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U.S. Department  
of Transportation  
**National Highway  
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**DOT HS 807 353**  
**Final Report**

**June 1987**



# **CRASH III Model Improvements: Derivation of New Side Stiffness Parameters from Crash Tests, Volume 2**

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| 16. Abstract<br><br>The CRASH III computer model uses physical evidence, such as various vehicle parameters and vehicle damage measurements, to reconstruct highway accidents. When damage measurements are used in a reconstruction, the model assumes a set of stiffness parameters which represent the resistance to crush for a group of vehicles. The set of parameters assumed is dependent on both the type of impact (frontal, side, or rear) and the type of vehicle(s) in the reconstruction. In the current model, stiffness parameters for passenger cars are categorized by wheelbase.<br><br>This report is divided into two volumes. Reported in this volume, Volume II, are the results of a study done to derive new side stiffness parameters for the CRASH III model. Eleven side impact crash tests were done to obtain the crush measurements necessary to derive these parameters.<br><br>Four vehicle models were tested. Occupant compartment impacts at two different impact speeds were done on each to derive stiffness parameters for these vehicles. One of these models was re-tested at a third speed to determine if the derived stiffness parameters were velocity sensitive. This same model was also used in non-compartment impacts, again at two speeds, to explore any impact location sensitivity. The results of these investigations are presented. |  |                                                          |                                                                                                                                              |                            |  |
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TECHNICAL SUMMARY

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| Report Title                                                                                            |           |
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| Donald T. Willke and Michael W. Monk                                                                    |           |

The CRASH III computer model was developed for use in highway accident reconstruction. The model uses physical evidence such as various vehicle parameters, vehicle trajectory information, and vehicle damage measurements. The primary outputs of the model are the vector changes in velocity ( $\Delta v$ ) of the vehicles resulting from the collision and impact speeds (only if trajectory information is available).

When damage measurements are used in a reconstruction, the model assumes a set of stiffness parameters which represent the resistance to crush for a group of vehicles. The set of parameters is dependent on both the impact mode (frontal, side, or rear) and the type of vehicle(s) in the reconstruction. In the current model, stiffness parameters for passenger cars are categorized according to wheelbase.

This report is divided into two volumes. Reported in this volume, Volume II, are the results of a study done to derive new side stiffness parameters for the CRASH III model. Eleven side impact crash tests were done to obtain the crush measurements necessary to derive these parameters.

Four vehicle models were tested. These were the Ford Escort, the Mitsubishi Tredia, the Chevrolet Citation, and the Ford LTD. Two occupant compartment impacts were done on each, using a low and a high impact speed. These resulted in  $\Delta v$ 's of 10 and 20 mph, respectively, on the subject car. From each pair of tests, a set of stiffness parameters was derived. These were compared to the side stiffness parameters currently used in the model.

A third crash test was performed on a Citation, with an impact speed resulting in a  $\Delta v$  of 25 mph. When paired with the previous low speed test results for that car, a second set of Citation stiffness parameters was derived. This enabled a determination to be made as to whether or not there was velocity sensitivity in the parameters derived. The Citation was also used in low and high speed non-occupant compartment crash tests. This allowed a comparison between the stiffness parameters found from striking the car in different locations.



## CRASH III MODEL IMPROVEMENTS:

### Derivation of New Side Stiffness Parameters From Crash Tests

#### 1.0 INTRODUCTION

The CRASH III\* computer program was developed for use in highway accident reconstruction. The model uses physical evidence such as various vehicle parameters, vehicle trajectory information, and vehicle damage measurements. In the absence of trajectory measurements, the reconstruction is based solely on vehicle damage measurements, and vice versa. In the absence of both trajectory and damage measurements, reconstruction is based solely on the Collision Damage Classification (CDC). The primary outputs of the model are the vector changes in velocity ( $\Delta V$ ) of the vehicle(s) resulting from the collision and impact speeds (only if trajectory information is available).

When damage measurements are used in a reconstruction, the model assumes a set of stiffness parameters which represent the resistance to crush for a group of vehicles. The set of parameters assumed is dependent on both the impact mode (frontal, side, or rear) and the type of vehicle(s) in the reconstruction. In the current model, stiffness parameters for passenger cars are categorized according to wheelbase.

For each impact mode, stiffness parameters were derived from crash test data. The side parameters currently in the model are based on very little data due to a lack of appropriate crash tests in this mode. A portion of this effort was to perform nine occupant compartment crash tests and two non-compartment impacts from which the resulting data could be used to derive side stiffness parameters. This report presents the data from these tests as well as the parameters found.

\* Calspan Reconstruction of Accident Speeds on the Highway, Version 3

## 2.0 OBJECTIVE

The purposes of this study were to derive new side stiffness parameters for use in the CRASH III model, and to examine the sensitivity of those parameters to variations in test and measurement procedures. Stiffness parameters were obtained by designing and conducting a side impact crash test program, measuring crush values, and performing the necessary calculations.

## 3.0 TEST PROCEDURES

### 3.1 Test Conditions

Prior to conducting the crash tests, it was necessary to select the vehicles and define the conditions for each test. These conditions included impact velocity, location, and angle as well as the type and size of striking vehicle to be used.

Four passenger cars were selected, one in each of the four shortest wheelbase categories. They were the Ford Escort, the Mitsubishi Tredia, the Chevrolet Citation, and the Ford LTD.

It was judged that half of the crash tests should be done at a relatively low speed ( $\Delta V \approx 10$  mph) while the others should be performed at a higher speed ( $\Delta V \approx 20$ -25 mph). In the study of Reference 1, frontal and rear stiffness parameters were calculated based on crash tests performed at higher speeds only. During that study, it was found that these did a poor job of predicting the velocity changes of low severity collisions. Consequently, they were adjusted such that the lower speed collisions could be more accurately modelled. The adjusted parameters are those currently used in the CRASH III model. It was felt that this type of adjustment would not be necessary if the parameters were derived from both low and high speed crash test data.

A low speed  $\Delta V$  of 10 mph and a high speed  $\Delta V$  of 20 mph were selected for most of the tests. (One high speed test was conducted at a

$\Delta V$  of 25 mph.) The struck car was stationary in each case and the impacting speed of the striking vehicle (NHTSA's moving barrier with a rigid front) varied based upon its weight and that of the struck car. This impact velocity was calculated as follows:

$$v_B = \frac{m_T}{m_B}(\Delta V)$$

This formula assumed a plastic collision where  $m_B$  was the mass of the moving barrier,  $m_T$  was the combined mass of the barrier and struck car, and  $v_B$  was the velocity of the barrier, or the impact velocity.

It was felt that the low speed test would not significantly damage the opposite side of the struck car. It was therefore possible to perform two collisions on each vehicle. First, the left side was impacted at the lower speed, and then the car was turned around and struck on the right side at the higher speed. This produced a low/high speed pair of data points for each car tested as well as conserved project funds.

It was also necessary to define the impact location on each car. Nine occupant compartment impacts and two impacts into the front axle were conducted. For the occupant compartment impacts, it was desired to avoid other structures such as the axles. It was also desired to center the impact as near to the struck vehicle's longitudinal center of gravity as possible, to minimize rotation. In most cases, centering the barrier on the vehicle's c.g. resulted in contact into the front wheelwell. Therefore, the impact location was selected for each car such that the leading edge of the barrier face was slightly rearward of the front wheelwell. The result of this was that the center of the impact area was slightly rearward of the vehicle's c.g. for each case. The non-compartment pair of tests was done with the same vehicle model as one of the pairs of compartment impacts. This allowed a comparison between the two types of impacts. Figures 3.1 and 3.2 show the pre-test set-up for one of the LTD tests.

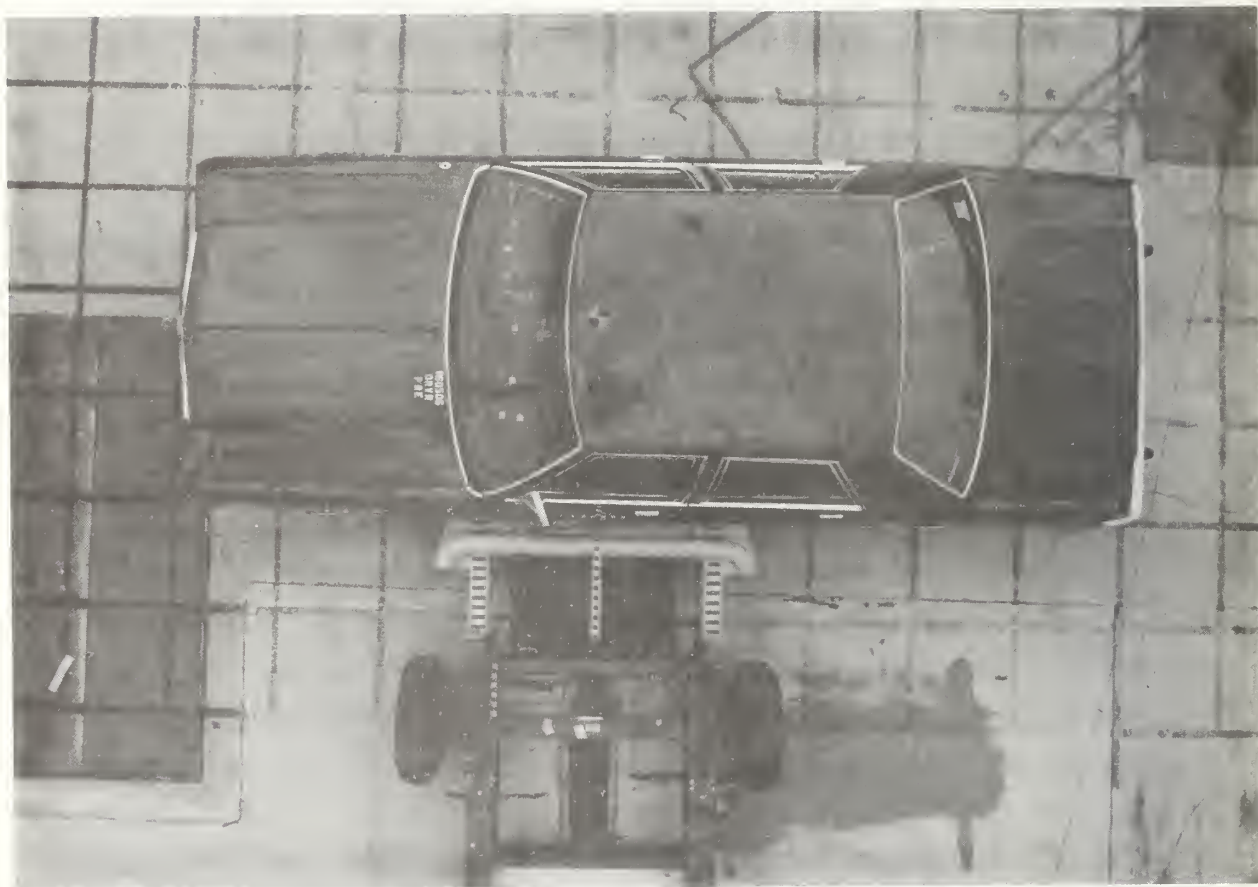


FIGURE 3.1 -- LTD Pre-Test Overhead View



FIGURE 3.2 -- LTD Pre-Test Side View

The NHTSA moving barrier is capable of performing impacts at different angles as well as being "crabbed" to simulate two-car moving collisions. It was judged that a 90° impact without crabbing would allow the most straight forward derivation of stiffnesses. Crabbing is probably more representative of real world collisions but the analysis is complicated by vehicle shearing and rotation.

As mentioned, the striking vehicle for each test was the NHTSA moving barrier with a rigid front. Typically, this device is used in conjunction with a deformable honeycomb front to simulate the front end stiffness of the impacting vehicle. To determine the stiffness characteristics, however, the energy used in deforming the struck vehicle must be calculated. If deformation also occurs in the striking vehicle, it is difficult, if not impossible, to determine how much of the energy caused the struck vehicle deformation. Therefore, in order to make it possible to accurately determine the amount of energy expended in deforming the struck vehicle, a rigid front was constructed for the moving barrier.

This rigid front was built to be approximately representative of the geometry of cars on the road. The frontal geometry of a number of vehicles was measured and sales weighted averages computed. These averages are listed below. Since they are based upon a relatively small sample, the numbers are not recommended for other applications. The weight of the barrier with this rigid front installed was 3237 lb (see Figure 3.3).

[NOTE: It is emphasized that this rigid barrier has no connection with the NHTSA Moving Deformable Barrier (MDB). This barrier is designed to be approximately representative of the geometry of passenger cars. The MDB is designed to represent both the geometry and stiffness of passenger cars and light trucks and vans.]

frontal width - 62.5"  
hood height - 30"  
bumper width - 6"  
bumper height - 17" (center)



FIGURE 3.3 -- Rigid Front for NHTSA Moving Barrier

### 3.2 Crush Measurement Procedures

Data were collected from each test, including ten channels of acceleration. Three accelerometers were located at the struck vehicle's c.g. and two at the rear deck. Three were also located at the barrier c.g., with two at the rear cross-member. The most significant data collected, though, were the post-test crush measurements. It was necessary, therefore, to find a uniform method of obtaining these measurements. Mr. Robert Romberg, NHTSA's NASS Training Coordinator, Traffic Safety Institute, visited the VRTC to demonstrate the procedure used by accident investigation teams in the field as well as to take the damage measurements from the vehicles tested in this study. This method is described in the following text.

First, the length of damage, L, was determined. The rearward and forward most points of damage, including both direct and induced damage, were located. The distance between these two points was recorded as 'L' and a string line was attached between the points. This length was then divided into five equal parts which were marked off along the string. These marks represented the six crush measurement locations, C1 to C6, with C1 being the rearward most point of damage and C6 being the forward most point of damage.

Using a plumb bob and a tape measure, the horizontal distance from the string line to the sheet metal, at the height of maximum crush, was measured and recorded for each of locations C1 through C6. Using the undamaged side of the vehicle, the distance from the string line to the undamaged sheet metal at these same locations was measured and recorded as 'freespace'. This distance was then subtracted from the maximum intrusion measured previously and recorded as 'net maximum crush'. If there was no major structural failure, such as the B-pillar tearing away at the sill, and there was no bowing of the car, these adjusted measurements were used as the final values for C1 through C6.

If there was major structural damage, the sill crush was also used. As with the maximum crush, the horizontal distance from the string line

to the sill was measured at each of the six locations. After obtaining the 'sill freespace' in the same manner as above, this value was subtracted from each of the previously measured distances. This 'net sill crush' was then averaged with the 'net maximum crush' described previously. If there was no bowing of the car, these 'net average crush' measurements were used as the final values for C1 through C6.

The bowing factor was determined in the following manner. Using the roof as a reference, a line was made through the original longitudinal centerline of the car. If neither the front nor the rear of the car had been displaced more than four inches, the bowing factor was zero. Otherwise, a second string line was attached to the side of the car at the most protruding structures in both the front and rear of the car. The horizontal distance from this string to the first string was measured and recorded at the C1 and C6 locations. The average of these two values was the bowing factor. Final values for C1 through C6 were then found by adding this bowing factor to each of the 'net maximum' or 'net average' crush values found as described previously.

The last damage measurement was the center of damage (c.o.d.) offset, D. The c.o.d. was located at a distance of  $L/2$  from both the C1 and C6 locations along the first string line. The distance from the c.o.d. to the vehicle's c.g. was recorded as D. This value was positive if the c.o.d. was forward of the c.g. and negative if it was rearward of the c.g. It is important to note that accident investigation teams in the field estimate the c.g. of a car to be the center of the wheelbase. Their D measurements are therefore the distance from the c.o.d. to the center of the wheelbase. Since the actual c.g. of the cars were known in this study, all reported D measurements are relative to the actual c.g.

Although this procedure appeared to be a very straight forward approach to obtaining the desired damage measurements, there was a degree of subjectivity in it. For instance, defining the area of damage, the length of which was defined as 'L', was not always clear cut. Frequently, very minor induced damage occurred outside of the area

that would intuitively be included in the damage region. This made it necessary to subjectively decide whether or not to extend the damage region to this point. Due to this type of occurrence as well as the location of the damage relative to wheelwells and vehicle discontinuities, it was often very difficult to determine what to include in this region. This measurement would therefore be expected to vary somewhat, depending on the person taking it. This would then affect the location of the six crush measurements, to some extent their magnitudes, and the offset value, D.

As mentioned previously, it was also necessary to determine if major structural failure had occurred. While this would certainly be very obvious in some cases, it would not always be expected to be clear cut. Since the maximum and sill crush measurements were greatly different and were averaged if failure occurred, the final crush values were very dependent on the outcome of this decision. Mr. Romberg suggested that one possible alternative to this potential source of variability would be to change the field procedure to always average the maximum and sill crush measurements. This would also give a better overall description of the extent of the damage than just the maximum crush measurement. Although sill crush measurements were taken for all the tests done in this study, they were not used unless it was determined that major structural failure occurred (i.e., the existing field procedure was followed).

## 4.0 RESULTS

### 4.1 Compartment Tests With 10 and 20 mph Delta-V's

A total of eleven channels of data were recorded for each test. These included the ten channels of acceleration outlined in section 3.2 and a yaw rate channel. These results can be found in the crash test report issued for each vehicle. The main outcome of these tests were the post-test damage measurements. Table 4.1 lists the various conditions and parameters for each of the eight compartment impact tests which were done at a  $\Delta V$  of either 10 or 20 mph. Table 4.2 lists the

TABLE 4.1 -- Test Conditions &amp; Parameters

Compartment Tests @ 10 & 20 mph  $\Delta V$ 's

| Vehicle            | Test Number | Impact Type | Vehicle Weight (lb) | MRB Speed (mph) | $\Delta V$ (mph) |
|--------------------|-------------|-------------|---------------------|-----------------|------------------|
| Ford Escort        | 8605161     | comp        | 1985                | 16.1            | 10.0             |
|                    | 8605162     | comp        | 1985                | 32.2            | 20.0             |
| Mitsubishi Tredia  | 8605231     | comp        | 2161                | 16.7            | 10.0             |
|                    | 8605232     | comp        | 2161                | 33.5            | 19.9             |
| Chevrolet Citation | 8603261     | comp        | 2784                | 18.5            | 10.0             |
|                    | 861015      | comp        | 2420                | 35.2            | 20.0             |
| Ford LTD           | 8605061     | comp        | 3554                | 20.9            | 10.0             |
|                    | 8605062     | comp        | 3554                | 42.1            | 20.1             |

TABLE 4.2 -- Damage Measurements

Compartment Tests @ 10 & 20 mph  $\Delta V$ 's

| Vehicle            | Damage Measurements (inches) |     |      |      |      |      |     |       |
|--------------------|------------------------------|-----|------|------|------|------|-----|-------|
|                    | L                            | C1  | C2   | C3   | C4   | C5   | C6  | D     |
| Ford Escort        | 75.0                         | 0.0 | 5.3  | 5.2  | 5.6  | 5.2  | 0.0 | -13.1 |
|                    | 102.0                        | 3.2 | 19.0 | 19.2 | 19.7 | 18.6 | 3.2 | -14.6 |
| Mitsubishi Tredia  | 80.0                         | 0.0 | 4.2  | 4.2  | 5.0  | 5.5  | 0.0 | -14.8 |
|                    | 99.5                         | 0.7 | 11.9 | 16.0 | 14.4 | 13.3 | 0.7 | -12.8 |
| Chevrolet Citation | 78.0                         | 0.0 | 9.1  | 8.6  | 8.7  | 8.3  | 0.0 | -11.1 |
|                    | 100.0                        | 1.8 | 17.5 | 17.0 | 17.5 | 10.0 | 1.8 | -9.5  |
| Ford LTD           | 85.3                         | 0.0 | 6.7  | 6.0  | 6.2  | 6.1  | 0.0 | -4.9  |
|                    | 138.5                        | 1.0 | 8.2  | 21.1 | 14.7 | 12.4 | 1.0 | 0.1   |

damage measurements obtained from each of these tests. Appendix A contains the work sheets for each test that were used to determine these measurements. Appendix B contains force vs. deflection plots for each test.

When damage measurements are used for reconstructions, the CRASH III model assumes the form of crush resistance shown in Figure 4.1. For this formulation, it is necessary to know the values of three stiffness parameters, A, B, and G, which are defined in the figure. There is a set of these parameters for each of the six passenger car side impact categories, which were derived in the study of Reference 1. These categories are divided by wheelbase as follows:

| <u>Category</u> | <u>Classification</u> | <u>Wheelbase</u> |
|-----------------|-----------------------|------------------|
| 1               | minicar               | 80.9 to 94.8     |
| 2               | subcompact            | 94.8 to 101.6"   |
| 3               | compact               | 101.6 to 110.4"  |
| 4               | intermediate          | 110.4 to 117.5"  |
| 5               | full size             | 117.5 to 123.2"  |
| 6               | large                 | 123.2 to 150.0"  |

To calculate the compartment stiffness parameters from the 10 and 20 mph  $\Delta V$  crash tests of this study, the data listed in Tables 4.1 and 4.2 were run through the CRUSH algorithm (2). From this, three values were calculated, E,  $\alpha$ , and  $\beta$ . E is the energy absorbed in the collision (in·lbs),  $\alpha$  is the plan view area of damage assuming a uniform vertical damage profile (in<sup>2</sup>), and  $\beta$  is the first moment of this damage area about the line defining the original (undeformed) surface (in<sup>3</sup>). A copy of the CRUSH run for each test can be found in Appendix C.

Once these CRUSH values were found for all the cars, they were entered into the NLIN routine from the Statistical Analysis System (SAS) package. Also entered was the damage length, L, for each test. The NLIN routine will find an A and B, and thus G, for any number of sets of CRUSH values, greater than one. These are found such that the following energy equation is fit, to meet a given convergence criterion, for each individual test:

$$E = A\alpha + B\beta + GL$$

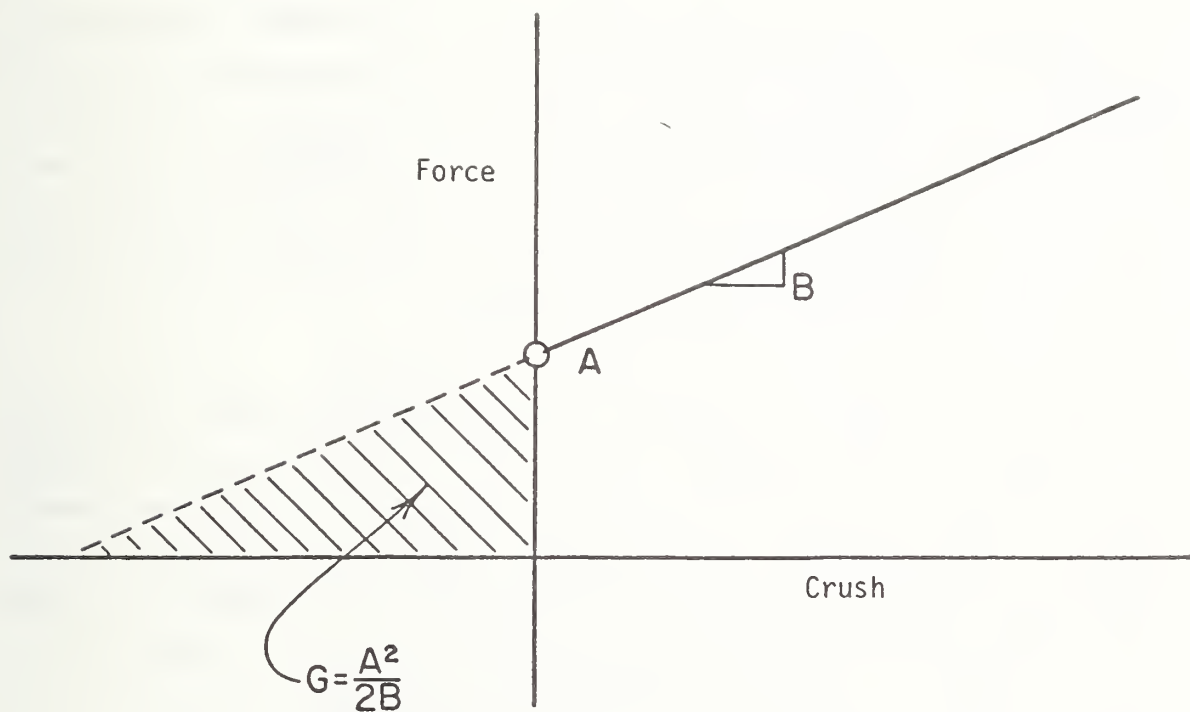


FIGURE 4.1 -- CRASH III Formulation for Crush Resistance

Stiffness parameters were calculated for each individual vehicle using the low and high speed test results, as well as for a combination of the vehicles. The vehicle models tested were chosen such that each was in a separate wheelbase category (1-Escort, 2-Tredia, 3-Citation, 4-LTD). Table 4.3 lists the parameters found for the individual cars (wheelbase categories), as well as for the combination. Table 4.4 lists the side stiffness parameters that are currently used in the CRASH III model.

Ultimately, the effectiveness of a set of stiffness parameters is measured by its ability to predict the velocity change of a collision when used in the CRASH III computer model. The parameter sets in Table 4.3 were entered into the program and used to reconstruct these same collisions. Ideally, these reconstructions would have been done with tests other than those used to calculate the parameters. This was not done since data of this type were very limited.

Table 4.5 lists the results of these reconstructions. Note that each crash was reconstructed using its individual set of stiffness parameters as well as the set found by combining all eight compartment impacts. As expected, the individual parameters did a good job of predicting velocity changes, with an average error of 2.9%. Even though this is a small error, closer agreement was expected since these collisions were used to calculate the stiffness parameters. The lack of near perfect reconstructions may be an indication of a deficiency in the model's energy formulation presented previously. As expected, the combined stiffness parameters produced less accurate reconstructions, with an average error of 16.0%. This observation that individual stiffness parameters produce better reconstructions than did a combined average cannot be extended to the general case where the collisions being reconstructed are not those that were used to derive the stiffness parameters. In fact, it was noted in Volume I of this final report that combined stiffness parameters worked nearly as well as categorized parameters.

TABLE 4.3 -- New Side Stiffness Parameters

Compartment Tests With 10 & 20 mph  $\Delta V$ 's

| Vehicle            | Wheelbase Category | Stiffness Parameter |       |        |
|--------------------|--------------------|---------------------|-------|--------|
|                    |                    | A                   | B     | G      |
| Escort             | 1                  | 141.4               | 11.09 | 901.1  |
| Tredia             | 2                  | 214.9               | 35.78 | 645.2  |
| Citation (comp)    | 3                  | 147.7               | 47.85 | 227.8  |
| LTD                | 4                  | 327.8               | 45.92 | 1169.7 |
| combined (8 tests) |                    | 236.7               | 13.75 | 2037.8 |

TABLE 4.4 -- Current Side Stiffness Parameters

| Wheelbase Category | Stiffness Parameter |      |       |
|--------------------|---------------------|------|-------|
|                    | A                   | B    | G     |
| 1                  | 77.2                | 36.7 | 81.3  |
| 2                  | 140.4               | 66.7 | 147.8 |
| 3                  | 173.3               | 57.1 | 263.2 |
| 4                  | 143.0               | 50.4 | 202.7 |
| 5,6                | 176.5               | 47.1 | 330.8 |

TABLE 4.5 -- Reconstruction Results

| Vehicle                         | Actual<br>$\Delta V$<br>(mph) | Predicted Velocity Change (mph) |          |             |            |          |             |
|---------------------------------|-------------------------------|---------------------------------|----------|-------------|------------|----------|-------------|
|                                 |                               | individual                      |          |             | combined   |          |             |
|                                 |                               | $\Delta V$                      | $\Delta$ | $\% \Delta$ | $\Delta V$ | $\Delta$ | $\% \Delta$ |
| Ford<br>Escort                  | 10.0                          | 9.5                             | -0.5     | 5.0%        | 13.2       | 3.2      | 32.0%       |
|                                 | 20.0                          | 18.7                            | -1.3     | 6.5%        | 24.0       | 4.0      | 20.0%       |
| Mitsubishi<br>Tredia            | 10.0                          | 9.7                             | -0.3     | 3.0%        | 12.8       | 2.8      | 28.0%       |
|                                 | 19.9                          | 19.5                            | -0.4     | 2.0%        | 19.5       | -0.4     | 2.0%        |
| Chevrolet<br>Citation<br>(comp) | 10.0                          | 9.7                             | -0.3     | 3.0%        | 12.2       | 2.2      | 22.0%       |
|                                 | 20.0                          | 19.4                            | -0.6     | 3.0%        | 19.0       | -1.0     | 5.0%        |
| Ford<br>LTD                     | 10.0                          | 9.9                             | -0.1     | 1.0%        | 9.9        | -0.1     | 1.0%        |
|                                 | 20.1                          | 20.1                            | 0.0      | 0.0%        | 16.5       | -3.6     | 17.9%       |
| average                         |                               | XXXXX                           |          | 2.9%        | XXXXXX     |          | 16.0%       |

#### 4.2 Tests With Alternate Impact Conditions

As mentioned previously, three additional crash tests were also done. Two of these were 10 and 20 mph  $\Delta V$  non-compartment tests on a Chevrolet Citation. In these tests, the moving rigid barrier was positioned such that the impact area on the car would include the front wheel and axle. The third test was a 25 mph  $\Delta V$  compartment impact also done on a Citation. In this test, the MRB was positioned the same as for the Citation tests listed in Table 4.1. Table 4.6 lists the test conditions and parameters for these three tests while Table 4.7 lists their crush measurements. Table 4.8 lists the stiffness parameters calculated from these results. The results of the 10 mph  $\Delta V$  Citation test listed in Table 4.2 were used in conjunction with those of the 25 mph  $\Delta V$  test to find the "alternate speed" parameters.

If the stiffnesses, B values, of these are compared with that for the Citation listed in Table 4.3, it can be seen that the stiffness increased significantly (123%) in the non-compartment impact. In

TABLE 4.6 -- Test Conditions &amp; Parameters

## Additional Citation Tests

| Vehicle            | Test Number | Impact Type | Vehicle Weight (lb) | MRB Speed (mph) | $\Delta V$ (mph) |
|--------------------|-------------|-------------|---------------------|-----------------|------------------|
| Chevrolet Citation | 8604291     | n-comp      | 2602                | 18.1            | 10.0             |
|                    | 8604292     | n-comp      | 2602                | 36.0            | 20.0             |
|                    | 8603262     | comp        | 2784                | 46.6            | 25.0             |

TABLE 4.7 -- Damage Measurements

## Additional Citation Tests

| Impact Type       | Damage Measurements (inches) |     |      |      |      |      |     |       |
|-------------------|------------------------------|-----|------|------|------|------|-----|-------|
|                   | L                            | C1  | C2   | C3   | C4   | C5   | C6  | D     |
| non-compartment   | 67.0                         | 2.7 | 6.2  | 6.2  | 5.8  | 3.9  | 1.4 | 13.5  |
|                   | 107.5                        | 0.0 | 5.1  | 16.0 | 12.2 | 6.9  | 0.0 | 8.5   |
| $\Delta V=25$ mph | 97.0                         | 7.0 | 10.7 | 29.9 | 28.6 | 28.1 | 7.0 | -14.4 |

TABLE 4.8 -- Side Stiffness Parameters

## Additional Citation Tests

| Impact Type     | Stiffness Parameter |       |       |
|-----------------|---------------------|-------|-------|
|                 | A                   | B     | G     |
| non-compartment | 239.1               | 106.7 | 267.7 |
| alternate speed | 168.6               | 36.85 | 385.8 |

addition, the threshold level for crush, the A value, also increased (62%). These increases were expected since intuitively, the axle area of a vehicle should be considerably more resistant to crush than the compartment side structure.

Similarly, a comparison of the 20 and 25 mph  $\Delta V$  test results show that the A value increased with increasing speed (14%), while the B value decreased (23%). While these results may suggest that the vehicle stiffness, model formulation, or both are velocity sensitive, the differences were not so large such that a determination of this could be made based on only two data points.

In addition to the variation in stiffness parameters due to the impacted region and impact velocities, that due to the variability in crush measurements was examined. In section 3.2, it was mentioned that the procedure for obtaining these measurements was somewhat subjective. In addition to Mr. Romberg's 'best effort' measurements listed in Table 4.2, he took measurements for each vehicle which bounded what he judged to be a reasonable range for damage area. That is, he took a set of measurements based on both the smallest reasonable and the largest reasonable damage length, L. This was done for the higher speed tests only and in four of the six tests, his 'best effort' measurements were also his 'largest L' measurements. These alternate measurements are listed in Appendix D as well as the stiffness parameters calculated when each set was paired with its corresponding low speed test.

Table 4.9 shows the percentage spread in stiffness parameters due to the variability in taking the crush measurements. The A parameters varied by an average of  $\pm 3.6\%$  while the B parameters varied by an average of  $\pm 12.2\%$ . The non-compartment Citation test showed the greatest variability in both parameters. This was due to the configuration of this particular test. Since the impact was much farther forward of the vehicle's c.g. than the other tests, more vehicle rotation occurred. This caused the rear wheel of the MRB to hit the rear door of the car, thus damaging it. While Mr. Romberg did not feel that he would include this damage, he thought that some accident investigators may.

TABLE 4.9 -- Measurement Variability on Stiffness Parameters

| Vehicle              | A           | B            |
|----------------------|-------------|--------------|
| Escort               | $\pm 2.6\%$ | $\pm 8.2\%$  |
| Tredia               | $\pm 1.1\%$ | $\pm 8.0\%$  |
| Citation<br>(comp)   | $\pm 4.1\%$ | $\pm 6.8\%$  |
| LTD                  | $\pm 1.8\%$ | $\pm 11.2\%$ |
| Citation<br>(n-comp) | $\pm 7.9\%$ | $\pm 25.0\%$ |
| Citation<br>(25 mph) | $\pm 3.9\%$ | $\pm 14.0\%$ |
| average              | $\pm 3.6\%$ | $\pm 12.2\%$ |

Thus his 'largest L' measurements included this damage, which had a large effect on the crush measurements and resulting stiffness parameters. It is important to note here that these ranges for damage lengths encompass the lengths that expert accident investigators would likely determine. If damage measurements are taken by less experienced personnel, the variability would be expected to increase.

## 5.0 SUMMARY

The following is a summary of the findings from this study:

1. Based on the results of the 10 and 20 mph  $\Delta V$  crash tests into the occupant compartments of four vehicles, the following side stiffness parameters were calculated:

| Vehicle  | wb Category | A     | B     | G      |
|----------|-------------|-------|-------|--------|
| Escort   | 1           | 141.4 | 11.09 | 901.1  |
| Tredia   | 2           | 214.9 | 35.78 | 645.2  |
| Citation | 3           | 147.7 | 47.85 | 227.8  |
| LTD      | 4           | 327.8 | 45.92 | 1169.7 |

2. When used in the CRASH III model to reconstruct these same tests, the above stiffness parameters had an average error of 2.9%. Although this was good, closer agreement was expected.
3. The results of all eight 10 and 20 mph  $\Delta V$  occupant compartment crash tests were combined to produce one set of stiffness parameters. These were  $A = 236.7$ ,  $B = 13.75$ , and  $G = 2037.8$ . Reconstructions of these tests using this set of parameters in the CRASH III model produced an average error of 16.0%
4. A set of stiffness parameters were found based on 10 and 20 mph  $\Delta V$  Citation non-compartment crash test results. When compared to that from the compartment tests, a sharp increase in crush resistance was seen. The following table summarizes these results:

| Stiffness<br>Parameter | compartment | non-<br>compartment | % increase |
|------------------------|-------------|---------------------|------------|
| A                      | 147.7       | 239.1               | 61.9%      |
| B                      | 47.85       | 106.7               | 123.0%     |

5. A set of stiffness parameters were found based on 10 and 25 mph  $\Delta V$  Citation compartment crash test results. The following table compares these parameters to those from the 10 and 20 mph  $\Delta V$  Citation compartment crash tests. The differences were not great enough to enable firm conclusions to be made as to the effect of speed variability on stiffness parameters or crush resistance.

| Stiffness<br>Parameter | 10/20 mph | 10/25 mph | % change |
|------------------------|-----------|-----------|----------|
| A                      | 147.7     | 168.6     | +14.2%   |
| B                      | 47.85     | 36.85     | -23.0%   |

6. Since the determination of the length of damage,  $L$ , is somewhat subjective, some variation in stiffness parameters for the same vehicle was expected due to the resulting variability in crush

measurements. For each vehicle, a range for L that could be expected from expert accident investigators was determined. Crush measurements were taken for each extreme of L and the corresponding stiffness parameters calculated. On average, variations of  $\pm 3.6\%$  and  $\pm 12.2\%$  were found for the A and B parameters, respectively. Higher variation would be expected if less experienced personnel were to make the crush measurements.

7. The results can be summarized graphically. Figure 5.1 shows the new and current A parameter values, including ranges due to measurement variability. For the most part, the new parameters are higher than the current ones. Figure 5.2 depicts the new and current B parameter values. The new B parameter values, for compartment impacts, are lower than the current ones, increasing with increasing wheelbase and leveling off for the larger cars. This plot also indicates that impact location is an important consideration since the front axle impact resulted in a much higher resistance to crush than any of the occupant compartment impacts.
8. For both the CRUSH and the CRASH III algorithms, the 'D' measurement is defined to be the distance from the center of the damage area to the center of gravity of the vehicle. Accident investigation teams use the center of the wheelbase as an approximation for the center of gravity. This introduces error in the energy calculations of these algorithms. It is felt that a better approximation for the center of gravity of a car could be made in the field, thus reducing this error.

## 6.0 RECOMMENDATIONS

The results of this study gave indication that smaller cars are less stiff in the compartment area than the CRASH III model values. The parameters derived for the front axle area are much stiffer than those

# 'A' PARAMETER COMPARISON

## wheelbase categories

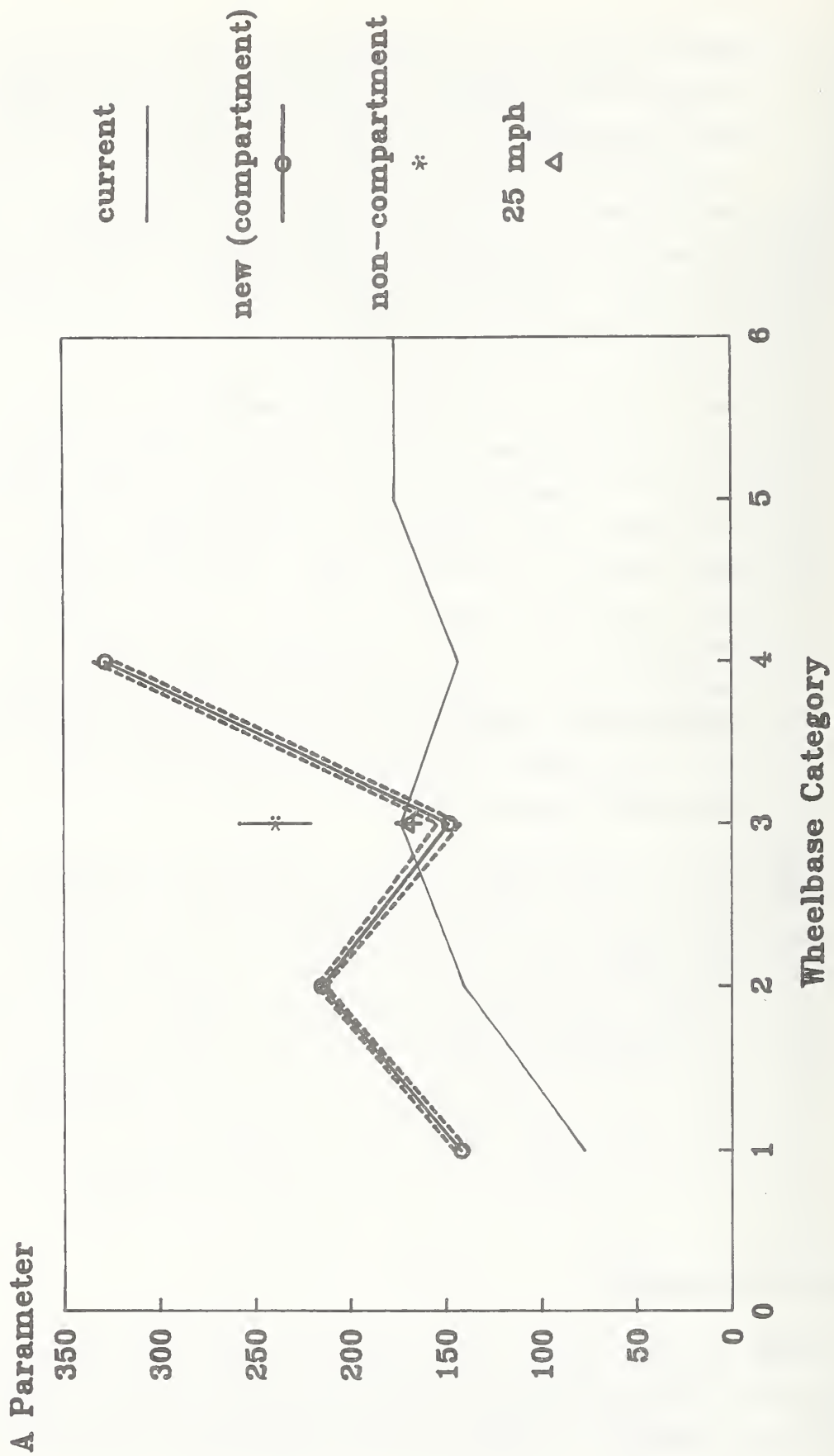


Figure 5.1. 'A' Parameter Comparison

# 'B' PARAMETER COMPARISON

## wheelbase categories

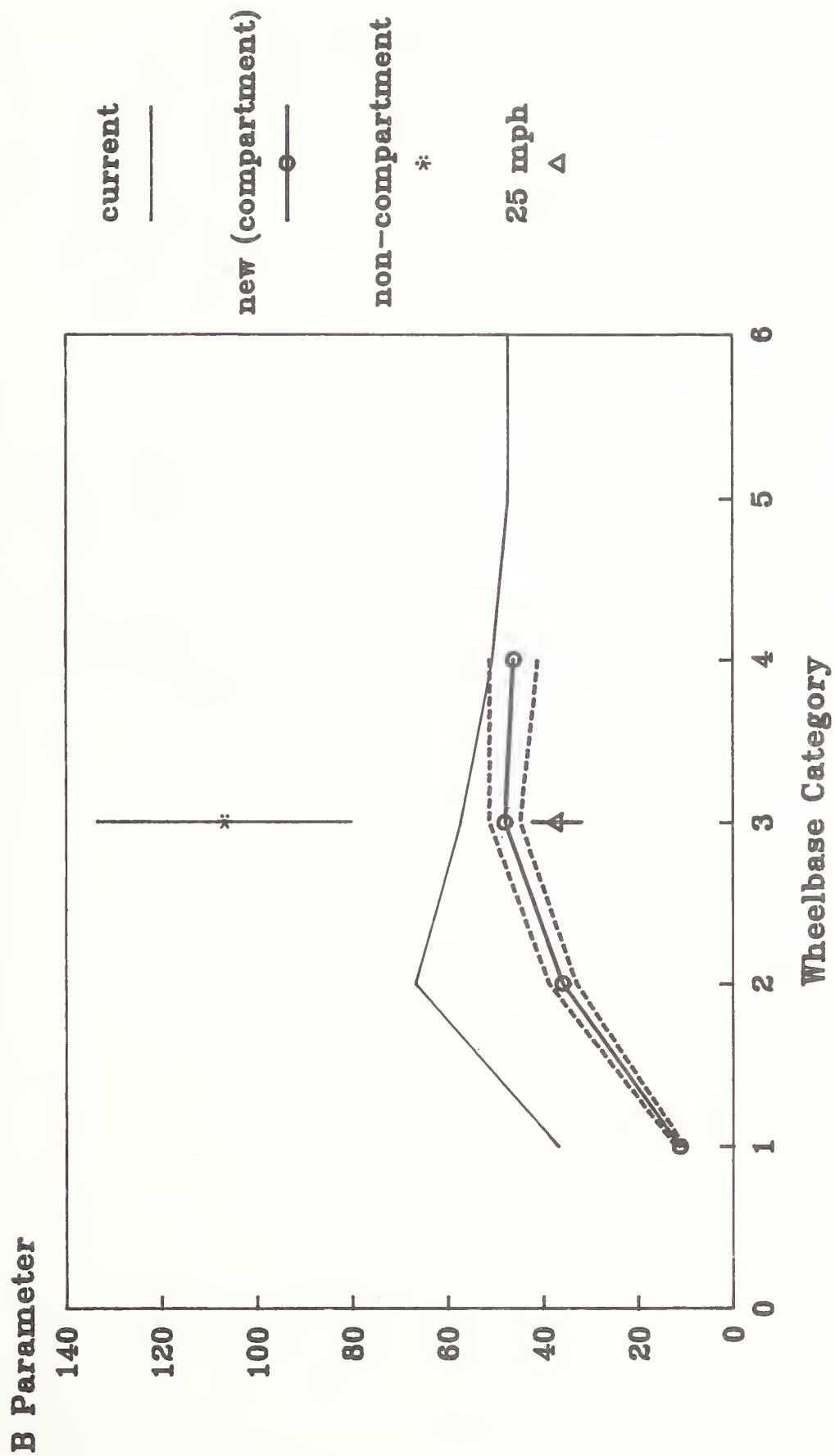


Figure 5.2. 'B' Parameter Comparison

in the model. Since each category was based upon crash test data from one vehicle model, the apparent recommendation would be to do sufficient tests and analysis to verify these differences. However, since a study is being initiated which might lead to a basic reformulation of the stiffness approach used in the CRASH III Model, it is recommended that further study of CRASH III stiffness values be postponed. Based upon the outcome of the reformulation, a decision can be made as to the need for further study of the findings documented in this report.

## 7.0 REFERENCES

1. M.W. Monk, D.A. Guenther; "Update of CRASH II Computer Model Damage Tables"; NHTSA final report numbers DOT-HS-806-446 (Volume I) and DOT-HS-806-447 (Volume II); March 1983.
2. R.R. McHenry; "Yielding-Barrier Test Data Base-Refinement of Damage Data Tables in the CRASH Program"; NHTSA Interim report number DOT-HS-802-265; February 1977.

## APPENDIX A

### Damage Measurement Worksheets

National Accident Sampling System — Continuous Sampling Subsystem: Vehicle Data

FIELD MEASUREMENTS

Escort - 10 mph

| Complete When Applicable                |                                                |
|-----------------------------------------|------------------------------------------------|
| End Damage                              | Side Damage                                    |
| Undeformed end width _____              | Bowing: B1 _____ X1 _____                      |
| Corner shift: A1 _____                  | B2 _____ X2 _____                              |
| A2 _____                                | Bowing constant                                |
| End shift at frame (CDC)<br>(check one) | $\frac{X1 + X2}{2} = \underline{\hspace{2cm}}$ |
| <4 inches <u>  X  </u>                  |                                                |
| ≥4 inches _____                         |                                                |

Note: Measure C1 to C6 from Driver to Passenger side in Front or Rear impacts-  
 Rear to Front in Side impacts.

| Specific Impact Number | Plane* of C-Measurements | Direct Damage |              | Field L** | C <sub>1</sub> | C <sub>2</sub> | C <sub>3</sub> | C <sub>4</sub> | C <sub>5</sub> | C <sub>6</sub> | ±D    |
|------------------------|--------------------------|---------------|--------------|-----------|----------------|----------------|----------------|----------------|----------------|----------------|-------|
|                        |                          | Width** (CDC) | Max*** Crush |           |                |                |                |                |                |                |       |
|                        | Maximum Crush            |               |              |           | 0              | 5.3            | 5.2            | 5.6            | 5.2            | 0              |       |
|                        | Freespace                |               |              |           | 0              | 0              | 0              | 0              | 0              | 0              |       |
|                        | Net Max. Crush           |               |              | 75        | 0              | 5.3            | 5.2            | 5.6            | 5.2            | 0              | -13.1 |
|                        |                          |               |              |           |                |                |                |                |                |                |       |
|                        | Sill Crush               |               |              |           | -              | 4.2            | 4.1            | 4.5            | 4.7            | -              |       |
|                        | Sill Freespace           |               |              |           | -              | 1.5            | 1.5            | 1.5            | 1.5            | -              |       |
|                        | Net Sill Crush           |               |              |           | -              | 2.7            | 2.6            | 3.0            | 3.2            | -              |       |
|                        |                          |               |              |           |                |                |                |                |                |                |       |

\*Identify the plane at which the C-measurements are taken (e.g., at bumper, above bumper, at sill, above sill, at beltline, etc.) or label adjustments (e.g., free space).

Free space value is defined as the distance between the baseline and the original body contour taken at the individual C locations. This may include the following: bumper lead, bumper taper, side protrusion, side taper, etc. Record the value for each C-measurement and maximum crush.

\*\*Measure and document on the vehicle diagram the beginning or end of the direct damage width and field L (e.g., side damage with respect to undamaged axle.)

\*\*\*Measure and document on the vehicle diagram the location of the maximum crush.

Note: Use as many lines/columns as necessary to describe each damage profile.

## National Accident Sampling System — Continuous Sampling Subsystem: Vehicle Data

## FIELD MEASUREMENTS

Tredia - 10 mph

NCI

| Complete When Applicable   |                             |
|----------------------------|-----------------------------|
| End Damage                 | Side Damage                 |
| Undeformed end width _____ | Bowing: B1 _____ X1 _____   |
| Corner shift: A1 _____     | B2 _____ X2 _____           |
| A2 _____                   | Bowing constant             |
| End shift at frame (CDC)   | $\frac{X1 + X2}{2} =$ _____ |
| (check one)                |                             |
| <4 inches <u>X</u>         |                             |
| ≥4 inches _____            |                             |

Note: Measure C1 to C6 from Driver to Passenger side in Front or Rear impacts—  
Rear to Front in Side impacts.

| Specific Impact Number | Plane* of C-Measurements | Direct Damage |              | Field L** | C <sub>1</sub> | C <sub>2</sub> | C <sub>3</sub> | C <sub>4</sub> | C <sub>5</sub> | C <sub>6</sub> | ±D    |
|------------------------|--------------------------|---------------|--------------|-----------|----------------|----------------|----------------|----------------|----------------|----------------|-------|
|                        |                          | Width** (CDC) | Max*** Crush |           |                |                |                |                |                |                |       |
|                        | Maximum Crush            |               |              |           | 0              | 5.0            | 5.0            | 5.8            | 6.3            | 0              |       |
|                        | Freospace                |               |              |           | -              | 0.8            | 0.8            | 0.8            | 0.8            | -              |       |
|                        | Net Max. Crush           |               |              | 80        | 0              | 4.2            | 4.2            | 5.0            | 5.5            | 0              | -14.8 |
|                        |                          |               |              |           |                |                |                |                |                |                |       |
|                        | Sill Crush               |               |              |           | -              | 3.0            | 3.5            | 3.7            | 4.0            | -              |       |
|                        | Sill Freespace           |               |              |           | -              | 3.0            | 3.0            | 3.0            | 3.0            | -              |       |
|                        | Net Sill Crush           |               |              |           | -              | 0              | 0.5            | 0.7            | 1.0            | -              |       |
|                        |                          |               |              |           |                |                |                |                |                |                |       |

\*Identify the plane at which the C-measurements are taken (e.g., at bumper, above bumper, at sill, above sill, at beltline, etc.) or label adjustments (e.g., free space).

Free space value is defined as the distance between the baseline and the original body contour taken at the individual C locations. This may include the following: bumper lead, bumper taper, side protrusion, side taper, etc. Record the value for each C-measurement and maximum crush.

\*\*Measure and document on the vehicle diagram the beginning or end of the direct damage width and field L (e.g., side damage with respect to undamaged axle.)

\*\*\*Measure and document on the vehicle diagram the location of the maximum crush.

Note: Use as many lines/columns as necessary to describe each damage profile.

## National Accident Sampling System — Continuous Sampling Subsystem: Vehicle Data

## FIELD MEASUREMENTS

Citation (compartment) - 10 mph

NCI

| Complete When Applicable                                          |                                                |
|-------------------------------------------------------------------|------------------------------------------------|
| End Damage                                                        | Side Damage                                    |
| Undeformed end width _____                                        | Bowing: B1 _____ X1 _____                      |
| Corner shift: A1 _____                                            | B2 _____ X2 _____                              |
| A2 _____                                                          | Bowing constant                                |
| End shift at frame (CDC)                                          | $\frac{X1 + X2}{2} = \underline{\hspace{2cm}}$ |
| (check one) <4 inches <input checked="" type="checkbox"/> X _____ |                                                |
| ≥4 inches _____                                                   |                                                |

Note: Measure C1 to C6 from Driver to Passenger side in Front or Rear impacts—  
Rear to Front in Side impacts.

| Specific Impact Number | Plane* of C-Measurements | Direct Damage |              | Field L** | C <sub>1</sub> | C <sub>2</sub> | C <sub>3</sub> | C <sub>4</sub> | C <sub>5</sub> | C <sub>6</sub> | ±D    |
|------------------------|--------------------------|---------------|--------------|-----------|----------------|----------------|----------------|----------------|----------------|----------------|-------|
|                        |                          | Width** (CDC) | Max*** Crush |           |                |                |                |                |                |                |       |
|                        |                          |               |              |           |                |                |                |                |                |                |       |
|                        | Maximum Crush            |               |              | 78        | 0              | 9.1            | 8.6            | 8.7            | 8.3            | 0              | -11.1 |
|                        |                          |               |              |           |                |                |                |                |                |                |       |
|                        | Hood Level Crush         |               |              |           | 0              | 5.6            | 6.5            | 5.1            | 4.4            | 0              |       |
|                        |                          |               |              |           |                |                |                |                |                |                |       |
|                        |                          |               |              |           |                |                |                |                |                |                |       |
|                        |                          |               |              |           |                |                |                |                |                |                |       |
|                        |                          |               |              |           |                |                |                |                |                |                |       |

\*Identify the plane at which the C-measurements are taken (e.g., at bumper, above bumper, at sill, above sill, at beltline, etc.) or label adjustments (e.g., free space).

Free space value is defined as the distance between the baseline and the original body contour taken at the individual C locations. This may include the following: bumper lead, bumper taper, side protrusion, side taper, etc. Record the value for each C-measurement and maximum crush.

\*\*Measure and document on the vehicle diagram the beginning or end of the direct damage width and field L (e.g., side damage with respect to undamaged axle.)

\*\*\*Measure and document on the vehicle diagram the location of the maximum crush.

Note: Use as many lines/columns as necessary to describe each damage profile.

## National Accident Sampling System — Continuous Sampling Subsystem: Vehicle Data

## FIELD MEASUREMENTS

LTD - 10 mph

NCI

| Complete When Applicable   |                                                |
|----------------------------|------------------------------------------------|
| End Damage                 | Side Damage                                    |
| Undeformed end width _____ | Bowing: B1 _____ X1 _____                      |
| Corner shift: A1 _____     | B2 _____ X2 _____                              |
| A2 _____                   | Bowing constant                                |
| End shift at frame (CDC)   | $\frac{X1 + X2}{2} = \underline{\hspace{2cm}}$ |
| (check one)                |                                                |
| <4 inches <u>  X  </u>     |                                                |
| ≥4 inches _____            |                                                |

Note: Measure C1 to C6 from Driver to Passenger side in Front or Rear impacts—  
Rear to Front in Side impacts.

| Specific Impact Number | Plane* of C-Measurements | Direct Damage |              | Field L** | C <sub>1</sub> | C <sub>2</sub> | C <sub>3</sub> | C <sub>4</sub> | C <sub>5</sub> | C <sub>6</sub> | ±D   |
|------------------------|--------------------------|---------------|--------------|-----------|----------------|----------------|----------------|----------------|----------------|----------------|------|
|                        |                          | Width** (CDC) | Max*** Crush |           |                |                |                |                |                |                |      |
|                        | Maximum Crush            |               |              |           | 0              | 9.0            | 8.3            | 8.5            | 8.4            | 0              |      |
|                        | Freospace                |               |              |           | -              | 2.3            | 2.3            | 2.3            | 2.3            | -              |      |
|                        | Net Max. Crush           |               |              | 85.3      | 0              | 6.7            | 6.0            | 6.2            | 6.1            | 0              | -4.9 |
|                        |                          |               |              |           |                |                |                |                |                |                |      |
|                        | Sill Crush               |               |              |           | -              | 5.7            | 6.8            | 6.4            | 6.4            | -              |      |
|                        | Sill Freespace           |               |              |           | -              | 4.3            | 4.3            | 4.3            | 4.3            | -              |      |
|                        | Net Sill Crush           |               |              |           | -              | 1.4            | 2.5            | 2.1            | 2.1            | -              |      |
|                        |                          |               |              |           |                |                |                |                |                |                |      |

\*Identify the plane at which the C-measurements are taken (e.g., at bumper, above bumper, at sill, above sill, at beltline, etc.) or label adjustments (e.g., free space).

Free space value is defined as the distance between the baseline and the original body contour taken at the individual C locations. This may include the following: bumper lead, bumper taper, side protrusion, side taper, etc. Record the value for each C-measurement and maximum crush.

\*\*Measure and document on the vehicle diagram the beginning or end of the direct damage width and field L (e.g., side damage with respect to undamaged axle.)

\*\*\*Measure and document on the vehicle diagram the location of the maximum crush.

Note: Use as many lines/columns as necessary to describe each damage profile.

## National Accident Sampling System – Continuous Sampling Subsystem: Vehicle Data

## FIELD MEASUREMENTS

Citation (non-compartment) - 10 mph

NCI

| Complete When Applicable                                                                                                                                            |                                                                                                                                 |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|
| End Damage                                                                                                                                                          | Side Damage                                                                                                                     |
| Undeformed end width _____<br><br>Corner shift: A1 _____<br><br>A2 _____<br>End shift at frame (CDC)<br>(check one)<br><4 inches <u>  X  </u><br>≥4 inches    _____ | Bowing: B1 _____ X1 _____<br><br>B2 _____ X2 _____<br><br>Bowing constant<br><br>$\frac{X1 + X2}{2} = \underline{\hspace{2cm}}$ |

Note: Measure C1 to C6 from Driver to Passenger side in Front or Rear impacts-  
 Rear to Front in Side impacts.

| Specific Impact Number | Plane* of C-Measurements | Direct Damage |              | Field L** | C <sub>1</sub> | C <sub>2</sub> | C <sub>3</sub> | C <sub>4</sub> | C <sub>5</sub> | C <sub>6</sub> | ±D    |
|------------------------|--------------------------|---------------|--------------|-----------|----------------|----------------|----------------|----------------|----------------|----------------|-------|
|                        |                          | Width** (CDC) | Max*** Crush |           |                |                |                |                |                |                |       |
|                        | Maximum Crush            |               |              |           | 3.5            | 7.0            | 7.0            | 6.6            | 4.8            | 2.5            |       |
|                        | Freospace                |               |              |           | 0.8            | 0.8            | 0.8            | 0.8            | 0.9            | 1.1            |       |
|                        | Net Max. Crush           |               |              | 67.0      | 2.7            | 6.2            | 6.2            | 5.8            | 3.9            | 1.4            | +13.5 |
|                        |                          |               |              |           |                |                |                |                |                |                |       |
|                        | Sill Crush               |               |              |           | 5.0            | 5.0            | 5.6            | 6.0            | -              | -              |       |
|                        | Sill Freespace           |               |              |           | 3.5            | 3.5            | 3.5            | 3.5            | -              | -              |       |
|                        | Net Sill Crush           |               |              |           | 1.5            | 1.5            | 2.1            | 2.5            | -              | -              |       |
|                        |                          |               |              |           |                |                |                |                |                |                |       |

\*Identify the plane at which the C-measurements are taken (e.g., at bumper, above bumper, at sill, above sill, at beltline, etc.) or label adjustments (e.g., free space).

Free space value is defined as the distance between the baseline and the original body contour taken at the individual C locations. This may include the following: bumper lead, bumper taper, side protrusion, side taper, etc. Record the value for each C-measurement and maximum crush.

\*\*Measure and document on the vehicle diagram the beginning or end of the direct damage width and field L (e.g., side damage with respect to undamaged axle.)

\*\*\*Measure and document on the vehicle diagram the location of the maximum crush.

Note: Use as many lines/columns as necessary to describe each damage profile.

## National Accident Sampling System — Continuous Sampling Subsystem: Vehicle Data

## FIELD MEASUREMENTS

Escort - 20 mph  
smallest L

NCI

| Complete When Applicable   |                                       |
|----------------------------|---------------------------------------|
| End Damage                 | Side Damage                           |
| Undeformed end width _____ | Bowing: B1 _____ X1 <u>6.7</u>        |
| Corner shift: A1 _____     | B2 _____ X2 <u>6.5</u>                |
| A2 _____                   | Bowing constant                       |
| End shift at frame (CDC)   | $\frac{X1 + X2}{2} = \underline{6.6}$ |
| (check one)                |                                       |
| <4 inches _____            |                                       |
| ≥4 inches <u>X</u>         |                                       |

Note: Measure C1 to C6 from Driver to Passenger side in Front or Rear impacts—  
Rear to Front in Side impacts.

| Specific Impact Number | Plane* of C-Measurements | Direct Damage |              | Field L** | C <sub>1</sub> | C <sub>2</sub> | C <sub>3</sub> | C <sub>4</sub> | C <sub>5</sub> | C <sub>6</sub> | ±D    |
|------------------------|--------------------------|---------------|--------------|-----------|----------------|----------------|----------------|----------------|----------------|----------------|-------|
|                        |                          | Width** (CDC) | Max*** Crush |           |                |                |                |                |                |                |       |
|                        | Maximum Crush            |               |              |           | 0              | 14.3           | 14.0           | 14.2           | 14.2           | 0              |       |
|                        | Freespace                |               |              |           | 0              | 0.8            | 0.8            | 0.8            | 0.8            | 0              |       |
| A                      | Net Max. Crush           |               |              |           | 0              | 13.5           | 13.2           | 13.4           | 13.4           | 0              |       |
|                        | Sill Crush               |               |              |           | -              | 9.0            | 8.8            | 9.5            | 10.1           | -              |       |
|                        | Sill Freespace           |               |              |           | -              | 2.5            | 2.5            | 2.5            | 2.5            | -              |       |
|                        | Net Sill Crush           |               |              |           | -              | 6.5            | 6.3            | 7.0            | 7.6            | -              |       |
| B                      | Bowing                   |               |              |           | 6.6            | 6.6            | 6.6            | 6.6            | 6.6            | 6.6            |       |
| A+B                    | Net Crush                |               |              | 85        | 6.6            | 20.1           | 19.8           | 20.0           | 20.0           | 6.6            | -17.6 |

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\*\*Measure and document on the vehicle diagram the beginning or end of the direct damage width and field L (e.g., side damage with respect to undamaged axle.)

\*\*\*Measure and document on the vehicle diagram the location of the maximum crush.

Note: Use as many lines/columns as necessary to describe each damage profile.

## National Accident Sampling System — Continuous Sampling Subsystem: Vehicle Data

## FIELD MEASUREMENTS

Escort - 20 mph  
largest L (best effort)

NCI

Complete When Applicable

| End Damage                              | Side Damage                           |
|-----------------------------------------|---------------------------------------|
| Undeformed end width _____              | Bowing: B1 _____ X1 <u>4.2</u>        |
| Corner shift: A1 _____                  | B2 _____ X2 <u>2.2</u>                |
| A2 _____                                | Bowing constant                       |
| End shift at frame (CDC)<br>(check one) | $\frac{X1 + X2}{2} = \underline{3.2}$ |
| <4 inches _____                         |                                       |
| ≥4 inches <u>X</u>                      |                                       |

Note: Measure C1 to C6 from Driver to Passenger side in Front or Rear impacts—  
Rear to Front in Side impacts.

| Specific<br>Impact<br>Number | Plane* of<br>C-Measurements | Direct Damage    |                 | Field<br>L** | C <sub>1</sub> | C <sub>2</sub> | C <sub>3</sub> | C <sub>4</sub> | C <sub>5</sub> | C <sub>6</sub> | ±D    |
|------------------------------|-----------------------------|------------------|-----------------|--------------|----------------|----------------|----------------|----------------|----------------|----------------|-------|
|                              |                             | Width**<br>(CDC) | Max***<br>Crush |              |                |                |                |                |                |                |       |
|                              | Maximum<br>Crush            |                  |                 |              | 0              | 16.8           | 17.0           | 17.5           | 16.4           | 0              |       |
|                              | Freespace                   |                  |                 |              | 0              | 1.0            | 1.0            | 1.0            | 1.0            | 0              |       |
| A                            | Net Max.<br>Crush           |                  |                 |              | 0              | 15.8           | 16.0           | 16.5           | 15.4           | 0              |       |
|                              | Sill<br>Crush               |                  |                 |              | -              | 11.5           | 12.1           | 13.0           | 12.8           | -              |       |
|                              | Sill<br>Freespace           |                  |                 |              | -              | 2.5            | 2.5            | 2.5            | 2.5            | -              |       |
|                              | Net Sill<br>Crush           |                  |                 |              | -              | 9.0            | 9.6            | 10.5           | 10.3           | -              |       |
| B                            | Bowing                      |                  |                 |              | 3.2            | 3.2            | 3.2            | 3.2            | 3.2            | 3.2            |       |
| A+B                          | Net Crush                   |                  |                 | 102.0        | 3.2            | 19.0           | 19.2           | 19.7           | 18.6           | 3.2            | -14.6 |

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\*\*Measure and document on the vehicle diagram the beginning or end of the direct damage width and field L (e.g., side damage with respect to undamaged axle.)

\*\*\*Measure and document on the vehicle diagram the location of the maximum crush.

Note: Use as many lines/columns as necessary to describe each damage profile.

## National Accident Sampling System — Continuous Sampling Subsystem: Vehicle Data

## FIELD MEASUREMENTS

Tredia - 20 mph  
smallest L

NCI

| Complete When Applicable                |                                       |
|-----------------------------------------|---------------------------------------|
| End Damage                              | Side Damage                           |
| Undeformed end width _____              | Bowing: B1 _____ X1 <u>1.7</u>        |
| Corner shift: A1 _____                  | B2 _____ X2 <u>6.5</u>                |
| A2 _____                                | Bowing constant                       |
| End shift at frame (CDC)<br>(check one) | $\frac{X1 + X2}{2} = \underline{4.1}$ |
| <4 inches _____                         |                                       |
| ≥4 inches <u>X</u>                      |                                       |

Note: Measure C1 to C6 from Driver to Passenger side in Front or Rear impacts—  
Rear to Front in Side impacts.

| Specific Impact Number | Plane* of C-Measurements | Direct Damage |              | Field L** | C <sub>1</sub> | C <sub>2</sub> | C <sub>3</sub> | C <sub>4</sub> | C <sub>5</sub> | C <sub>6</sub> | ±D    |
|------------------------|--------------------------|---------------|--------------|-----------|----------------|----------------|----------------|----------------|----------------|----------------|-------|
|                        |                          | Width** (CDC) | Max*** Crush |           |                |                |                |                |                |                |       |
|                        | Maximum Crush            |               |              |           | 0              | 20.8           | 18.3           | 16.9           | 16.0           | 0              |       |
|                        | Freospace                |               |              |           | 0              | 0.8            | 0.8            | 0.8            | 0.8            | 0              |       |
| A                      | Net Max. Crush           |               |              |           | 0              | 20.0           | 17.5           | 16.1           | 15.2           | 0              |       |
|                        | Sill Crush               |               |              |           | -              | 5.5            | 10.6           | 10.0           | 8.6            | -              |       |
|                        | Sill Freespace           |               |              |           | -              | 5.0            | 5.0            | 5.0            | 5.0            | -              |       |
| B                      | Net Sill Crush           |               |              |           | -              | 0.5            | 5.6            | 5.0            | 3.6            | -              |       |
| C                      | Bowing                   |               |              |           | 4.1            | 4.1            | 4.1            | 4.1            | 4.1            | 4.1            |       |
| $\frac{A+B}{2} + C$    | Net Crush                |               |              | 81        | 4.1            | 14.4           | 15.7           | 14.7           | 13.5           | 4.1            | -15.8 |

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\*\*Measure and document on the vehicle diagram the beginning or end of the direct damage width and field L (e.g., side damage with respect to undamaged axle.)

\*\*\*Measure and document on the vehicle diagram the location of the maximum crush.

Note: Use as many lines/columns as necessary to describe each damage profile.

## National Accident Sampling System – Continuous Sampling Subsystem: Vehicle Data

## FIELD MEASUREMENTS

Tredia - 20 mph  
largest L (best effort)

NCI

Complete When Applicable

| End Damage                              | Side Damage                           |
|-----------------------------------------|---------------------------------------|
| Undeformed end width _____              | Bowing: B1 _____ X1 <u>0</u>          |
| Corner shift: A1 _____                  | B2 _____ X2 <u>1.4</u>                |
| A2 _____                                | Bowing constant                       |
| End shift at frame (CDC)<br>(check one) | $\frac{X1 + X2}{2} = \underline{0.7}$ |
| <4 inches _____                         |                                       |
| ≥4 inches <u>X</u>                      |                                       |

Note: Measure C1 to C6 from Driver to Passenger side in Front or Rear impacts–  
Rear to Front in Side impacts.

| Specific<br>Impact<br>Number | Plane* of<br>C-Measurements | Direct Damage    |                 | Field<br>L** | C <sub>1</sub> | C <sub>2</sub> | C <sub>3</sub> | C <sub>4</sub> | C <sub>5</sub> | C <sub>6</sub> | ±D    |
|------------------------------|-----------------------------|------------------|-----------------|--------------|----------------|----------------|----------------|----------------|----------------|----------------|-------|
|                              |                             | Width**<br>(CDC) | Max***<br>Crush |              |                |                |                |                |                |                |       |
|                              | Maximum<br>Crush            |                  |                 |              | 0              | 23.1           | 20.9           | 20.7           | 19.0           | 0              |       |
|                              | Freespace                   |                  |                 |              | 0              | 0.8            | 0.8            | 0.8            | 0.8            | 0              |       |
| A                            | Net Max.<br>Crush           |                  |                 |              | 0              | 22.3           | 20.1           | 19.9           | 18.2           | 0              |       |
|                              | Sill<br>Crush               |                  |                 |              | -              | 4.0            | 15.5           | 12.5           | 12.0           | -              |       |
|                              | Sill<br>Freespace           |                  |                 |              | -              | 5.0            | 5.0            | 5.0            | 5.0            | -              |       |
| B                            | Net Sill<br>Crush           |                  |                 |              | -              | 0              | 10.5           | 7.5            | 7.0            | -              |       |
| C                            | Bowing                      |                  |                 |              | 0.7            | 0.7            | 0.7            | 0.7            | 0.7            | 0.7            |       |
| $\frac{A+B}{2} + C$          | Net Crush                   |                  |                 | 99.5         | 0.7            | 11.9           | 16.0           | 14.4           | 13.3           | 0.7            | -12.8 |

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\*\*Measure and document on the vehicle diagram the beginning or end of the direct damage width and field L (e.g., side damage with respect to undamaged axle.)

\*\*\*Measure and document on the vehicle diagram the location of the maximum crush.

Note: Use as many lines/columns as necessary to describe each damage profile.

## National Accident Sampling System — Continuous Sampling Subsystem: Vehicle Data

## FIELD MEASUREMENTS

Citation (compartment) - 20 mph  
smallest L

NCI

| Complete When Applicable   |                                       |
|----------------------------|---------------------------------------|
| End Damage                 | Side Damage                           |
| Undeformed end width _____ | Bowing: B1 _____ X1 <u>2.4</u>        |
| Corner shift: A1 _____     | B2 _____ X2 <u>8.0</u>                |
| A2 _____                   | Bowing constant                       |
| End shift at frame (CDC)   | $\frac{X1 + X2}{2} = \underline{5.2}$ |
| (check one)                |                                       |
| <4 inches _____            |                                       |
| ≥4 inches <u>X</u>         |                                       |

Note: Measure C1 to C6 from Driver to Passenger side in Front or Rear impacts—  
Rear to Front in Side impacts.

| Specific Impact Number | Plane* of C-Measurements | Direct Damage |              | Field L** | C <sub>1</sub> | C <sub>2</sub> | C <sub>3</sub> | C <sub>4</sub> | C <sub>5</sub> | C <sub>6</sub> | ±D    |
|------------------------|--------------------------|---------------|--------------|-----------|----------------|----------------|----------------|----------------|----------------|----------------|-------|
|                        |                          | Width** (CDC) | Max*** Crush |           |                |                |                |                |                |                |       |
|                        | Maximum Crush            |               |              |           | 0              | 15.2           | 13.7           | 12.5           | 12.0           | 0              |       |
|                        | Freospace                |               |              |           | 0              | 0.8            | 0.8            | 0.8            | 0.8            | 0              |       |
| A                      | Net Max. Crush           |               |              |           | 0              | 14.4           | 12.9           | 11.7           | 11.8           | 0              |       |
|                        | Sill Crush               |               |              |           | -              | 9.6            | 12.0           | 9.6            | 8.0            | -              |       |
|                        | Sill Freespace           |               |              |           | -              | 5.5            | 5.5            | 5.5            | 5.5            | -              |       |
|                        | Net Sill Crush           |               |              |           | -              | 4.1            | 6.5            | 4.1            | 2.5            | -              |       |
| B                      | Bowing                   |               |              |           | 5.2            | 5.2            | 5.2            | 5.2            | 5.2            | 5.2            |       |
| A+B                    | Net Crush                |               |              | 81.5      | 5.2            | 19.6           | 18.1           | 16.9           | 17.0           | 5.2            | -15.0 |

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\*\*\*Measure and document on the vehicle diagram the location of the maximum crush.

Note: Use as many lines/columns as necessary to describe each damage profile.

## National Accident Sampling System – Continuous Sampling Subsystem: Vehicle Data

## FIELD MEASUREMENTS

Citation (compartment) – 20 mph

largest L (best effort)

NCI

Complete When Applicable

| End Damage                              | Side Damage                           |
|-----------------------------------------|---------------------------------------|
| Undeformed end width _____              | Bowing: B1 _____ X1 <u>2.0</u>        |
| Corner shift: A1 _____                  | B2 _____ X2 <u>1.6</u>                |
| A2 _____                                | Bowing constant                       |
| End shift at frame (CDC)<br>(check one) | $\frac{X1 + X2}{2} = \underline{1.8}$ |
| <4 inches _____                         |                                       |
| ≥4 inches <u>X</u>                      |                                       |

Note: Measure C1 to C6 from Driver to Passenger side in Front or Rear impacts–  
Rear to Front in Side impacts.

| Specific Impact Number | Plane* of C-Measurements | Direct Damage |              | Field L** | C <sub>1</sub> | C <sub>2</sub> | C <sub>3</sub> | C <sub>4</sub> | C <sub>5</sub> | C <sub>6</sub> | ±D   |
|------------------------|--------------------------|---------------|--------------|-----------|----------------|----------------|----------------|----------------|----------------|----------------|------|
|                        |                          | Width** (CDC) | Max*** Crush |           |                |                |                |                |                |                |      |
|                        | Maximum Crush            |               |              |           | 0              | 16.5           | 16.0           | 16.5           | 9.0            | 0              |      |
|                        | Freespace                |               |              |           | 0              | 0.8            | 10.8           | 0.8            | 0.8            | 0              |      |
| A                      | Net Max. Crush           |               |              |           | 0              | 15.7           | 15.2           | 15.7           | 8.2            | 0              |      |
|                        | Sill Crush               |               |              |           | -              | 13.0           | 13.7           | 12.6           | -              | -              |      |
|                        | Sill Freespace           |               |              |           | -              | 5.5            | 5.5            | 5.5            | -              | -              |      |
|                        | Net Sill Crush           |               |              |           | -              | 7.5            | 8.2            | 7.1            | -              | -              |      |
| B                      | Bowing                   |               |              |           | 1.8            | 1.8            | 1.8            | 1.8            | 1.8            | 1.8            |      |
| A+B                    | Net Crush                |               | 100.0        |           | 1.8            | 17.5           | 17.0           | 17.5           | 10.0           | 1.8            | -9.5 |

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\*\*\*Measure and document on the vehicle diagram the location of the maximum crush.

Note: Use as many lines/columns as necessary to describe each damage profile.

## National Accident Sampling System — Continuous Sampling Subsystem: Vehicle Data

## FIELD MEASUREMENTS

LTD - 20 mph  
smallest L

NCI

| Complete When Applicable                |                                       |
|-----------------------------------------|---------------------------------------|
| End Damage                              | Side Damage                           |
| Undeformed end width _____              | Bowing: B1 _____ X1 <u>4.7</u>        |
| Corner shift: A1 _____                  | B2 _____ X2 <u>3.5</u>                |
| A2 _____                                | Bowing constant                       |
| End shift at frame (CDC)<br>(check one) | $\frac{X1 + X2}{2} = \underline{4.1}$ |
| <4 inches _____                         |                                       |
| ≥4 inches <u>X</u>                      |                                       |

Note: Measure C1 to C6 from Driver to Passenger side in Front or Rear impacts—  
Rear to Front in Side impacts.

| Specific Impact Number | Plane* of C-Measurements | Direct Damage |              | Field L** | C <sub>1</sub> | C <sub>2</sub> | C <sub>3</sub> | C <sub>4</sub> | C <sub>5</sub> | C <sub>6</sub> | ±D   |
|------------------------|--------------------------|---------------|--------------|-----------|----------------|----------------|----------------|----------------|----------------|----------------|------|
|                        |                          | Width** (CDC) | Max*** Crush |           |                |                |                |                |                |                |      |
|                        | Maximum Crush            |               |              |           | 0              | 25.4           | 23.3           | 22.6           | 14.8           | 0              |      |
|                        | Freespace                |               |              |           | 0              | 2.3            | 2.3            | 2.3            | 1.0            | 0              |      |
| A                      | Net Max. Crush           |               |              |           | 0              | 23.1           | 21.0           | 20.3           | 13.8           | 0              |      |
|                        | Sill Crush               |               |              |           | -              | 10.7           | 20.0           | 9.3            | -              | -              |      |
|                        | Sill Freespace           |               |              |           | -              | 4.3            | 8.3            | 8.3            | -              | -              |      |
| B                      | Net Sill Crush           |               |              |           | -              | 6.4            | 11.7           | 1.0            | -              | -              |      |
| C                      | Bowing                   |               |              |           | 4.1            | 4.1            | 4.1            | 4.1            | 4.1            | 4.1            |      |
| $\frac{A+B}{2} + C$    | Net Crush                |               |              | 111.5     | 4.1            | 18.9           | 20.5           | 14.8           | 17.9           | 4.1            | -1.2 |

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\*\*\*Measure and document on the vehicle diagram the location of the maximum crush.

Note: Use as many lines/columns as necessary to describe each damage profile.

## National Accident Sampling System — Continuous Sampling Subsystem: Vehicle Data

## FIELD MEASUREMENTS

LTD - 20 mph  
largest L (best effort)

NCI

Complete When Applicable

| End Damage                              | Side Damage                           |
|-----------------------------------------|---------------------------------------|
| Undeformed end width _____              | Bowing: B1 _____ X1 <u>2.0</u>        |
| Corner shift: A1 _____                  | B2 _____ X2 <u>0</u>                  |
| A2 _____                                | Bowing constant                       |
| End shift at frame (CDC)<br>(check one) | $\frac{X1 + X2}{2} = \underline{1.0}$ |
| <4 inches _____                         |                                       |
| ≥4 inches <u>X</u>                      |                                       |

Note: Measure C1 to C6 from Driver to Passenger side in Front or Rear impacts—  
Rear to Front in Side impacts.

| Specific Impact Number | Plane* of C-Measurements | Direct Damage |              | Field L** | C <sub>1</sub> | C <sub>2</sub> | C <sub>3</sub> | C <sub>4</sub> | C <sub>5</sub> | C <sub>6</sub> | ±D   |
|------------------------|--------------------------|---------------|--------------|-----------|----------------|----------------|----------------|----------------|----------------|----------------|------|
|                        |                          | Width** (CDC) | Max*** Crush |           |                |                |                |                |                |                |      |
|                        | Maximum Crush            |               |              |           | 0              | 12.0           | 26.7           | 25.7           | 11.4           | 0              |      |
|                        | Freespace                |               |              |           | 0              | 2.3            | 2.3            | 2.3            | 0              | 0              |      |
| A                      | Net Max. Crush           |               |              |           | 0              | 9.7            | 24.4           | 23.4           | 11.4           | 0              |      |
|                        | Sill Crush               |               |              |           | -              | 9.0            | 24.0           | 12.2           | -              | -              |      |
|                        | Sill Freespace           |               |              |           | -              | 4.3            | 8.3            | 8.3            | -              | -              |      |
| B                      | Net Sill Crush           |               |              |           | -              | 4.7            | 15.7           | 3.9            | -              | -              |      |
| C                      | Bowing                   |               |              |           | 1.0            | 1.0            | 1.0            | 1.0            | 1.0            | 1.0            |      |
| $\frac{A+B}{2} + C$    | Net Crush                |               | 138.5        |           | 1.0            | 8.2            | 21.1           | 14.7           | 12.4           | 1.0            | +0.1 |

\*Identify the plane at which the C-measurements are taken (e.g., at bumper, above bumper, at sill, above sill, at beltline, etc.) or label adjustments (e.g., free space).

Free space value is defined as the distance between the baseline and the original body contour taken at the individual C locations. This may include the following: bumper lead, bumper taper, side protrusion, side taper, etc. Record the value for each C-measurement and maximum crush.

\*\*Measure and document on the vehicle diagram the beginning or end of the direct damage width and field L (e.g., side damage with respect to undamaged axle.)

\*\*\*Measure and document on the vehicle diagram the location of the maximum crush.

Note: Use as many lines/columns as necessary to describe each damage profile.

National Accident Sampling System — Continuous Sampling Subsystem: Vehicle Data

FIELD MEASUREMENTS

Citation (non-compartment) - 20 mph  
 smallest L (best effort)

NCI

| Complete When Applicable   |                                                |
|----------------------------|------------------------------------------------|
| End Damage                 | Side Damage                                    |
| Undeformed end width _____ | Bowing: B1 _____ X1 _____                      |
| Corner shift: A1 _____     | B2 _____ X2 _____                              |
| A2 _____                   | Bowing constant                                |
| End shift at frame (CDC)   | $\frac{X1 + X2}{2} = \underline{\hspace{2cm}}$ |
| (check one)                |                                                |
| <4 inches <u>  X  </u>     |                                                |
| ≥4 inches _____            |                                                |

Note: Measure C1 to C6 from Driver to Passenger side in Front or Rear impacts-  
 Rear to Front in Side impacts.

| Specific Impact Number | Plane* of C-Measurements | Direct Damage |              | Field L** | C <sub>1</sub> | C <sub>2</sub> | C <sub>3</sub> | C <sub>4</sub> | C <sub>5</sub> | C <sub>6</sub> | ±D   |
|------------------------|--------------------------|---------------|--------------|-----------|----------------|----------------|----------------|----------------|----------------|----------------|------|
|                        |                          | Width** (CDC) | Max*** Crush |           |                |                |                |                |                |                |      |
|                        | Maximum Crush            |               |              |           | 0              | 5.9            | 16.8           | 13.0           | 6.9            | 0              |      |
|                        | Freospace                |               |              |           | 0.8            | 0.8            | 0.8            | 0.8            | 0              | 0              |      |
|                        | Net Max. Crush           |               | 107.5        |           | 0              | 5.1            | 16.0           | 12.2           | 6.9            | 0              | +8.5 |
|                        |                          |               |              |           |                |                |                |                |                |                |      |
|                        | Sill Crush               |               |              |           | 3.5            | 6.0            | 10.9           | 9.0            | -              | -              |      |
|                        | Sill Freespace           |               |              |           | 3.5            | 3.5            | 3.5            | 3.5            | -              | -              |      |
|                        | Net Sill Crush           |               |              |           | 0              | 2.5            | 7.4            | 5.5            | -              | -              |      |
|                        |                          |               |              |           |                |                |                |                |                |                |      |

\*Identify the plane at which the C-measurements are taken (e.g., at bumper, above bumper, at sill, above sill, at beltline, etc.) or label adjustments (e.g., free space).

Free space value is defined as the distance between the baseline and the original body contour taken at the individual C locations. This may include the following: bumper lead, bumper taper, side protrusion, side taper, etc. Record the value for each C-measurement and maximum crush.

\*\*Measure and document on the vehicle diagram the beginning or end of the direct damage width and field L (e.g., side damage with respect to undamaged axle.)

\*\*\*Measure and document on the vehicle diagram the location of the maximum crush.

Note: Use as many lines/columns as necessary to describe each damage profile.

## National Accident Sampling System — Continuous Sampling Subsystem: Vehicle Data

## FIELD MEASUREMENTS

Citation (non-compartment) - 20 mph

largest L

NCI

Complete When Applicable

| End Damage                              | Side Damage                                    |
|-----------------------------------------|------------------------------------------------|
| Undeformed end width _____              | Bowing: B1 _____ X1 _____                      |
| Corner shift: A1 _____                  | B2 _____ X2 _____                              |
| A2 _____                                | Bowing constant                                |
| End shift at frame (CDC)<br>(check one) | $\frac{X1 + X2}{2} = \underline{\hspace{2cm}}$ |
| <4 inches <u>  X  </u>                  |                                                |
| ≥4 inches _____                         |                                                |

Note: Measure C1 to C6 from Driver to Passenger side in Front or Rear impacts—  
Rear to Front in Side impacts.

| Specific<br>Impact<br>Number | Plane* of<br>C-Measurements | Direct Damage    |                 | Field<br>L** | C <sub>1</sub> | C <sub>2</sub> | C <sub>3</sub> | C <sub>4</sub> | C <sub>5</sub> | C <sub>6</sub> | ±D   |
|------------------------------|-----------------------------|------------------|-----------------|--------------|----------------|----------------|----------------|----------------|----------------|----------------|------|
|                              |                             | Width**<br>(CDC) | Max***<br>Crush |              |                |                |                |                |                |                |      |
|                              | Maximum<br>Crush            |                  |                 |              | 0              | 5.7            | 20.0           | 15.8           | 8.0            | 0              |      |
|                              | Freespace                   |                  |                 |              | 3.4            | 3.0            | 2.4            | 2.0            | 0.6            | 0              |      |
|                              | Net Max.<br>Crush           |                  |                 | 120.0        | 0              | 2.7            | 17.6           | 13.8           | 7.4            | 0              | +5.3 |
|                              |                             |                  |                 |              |                |                |                |                |                |                |      |
|                              | Sill<br>Crush               |                  |                 |              | -              | 7.2            | 11.6           | 11.3           | -              | -              |      |
|                              | Sill<br>Freespace           |                  |                 |              | -              | 5.7            | 5.1            | 4.7            | -              | -              |      |
|                              | Net Sill<br>Crush           |                  |                 |              | -              | 1.5            | 6.5            | 6.6            | -              | -              |      |
|                              |                             |                  |                 |              |                |                |                |                |                |                |      |

\*Identify the plane at which the C-measurements are taken (e.g., at bumper, above bumper, at sill, above sill, at beltline, etc.) or label adjustments (e.g., free space).

Free space value is defined as the distance between the baseline and the original body contour taken at the individual C locations. This may include the following: bumper lead, bumper taper, side protrusion, side taper, etc. Record the value for each C-measurement and maximum crush.

\*\*Measure and document on the vehicle diagram the beginning or end of the direct damage width and field L (e.g., side damage with respect to undamaged axle.)

\*\*\*Measure and document on the vehicle diagram the location of the maximum crush.

Note: Use as many lines/columns as necessary to describe each damage profile.

## National Accident Sampling System — Continuous Sampling Subsystem: Vehicle Data

## FIELD MEASUREMENTS

Citation (compartment) - 25 mph  
best effort

NCI

| Complete When Applicable   |                                       |
|----------------------------|---------------------------------------|
| End Damage                 | Side Damage                           |
| Undeformed end width _____ | Bowing: B1 _____ X1 <u>2.5</u>        |
| Corner shift: A1 _____     | B2 _____ X2 <u>11.5</u>               |
| A2 _____                   | Bowing constant                       |
| End shift at frame (CDC)   | $\frac{X1 + X2}{2} = \underline{7.0}$ |
| (check one)                |                                       |
| <4 inches _____            |                                       |
| ≥4 inches <u>X</u>         |                                       |

Note: Measure C1 to C6 from Driver to Passenger side in Front or Rear impacts—  
Rear to Front in Side impacts.

| Specific Impact Number | Plane* of C-Measurements | Direct Damage |              | Field L** | C <sub>1</sub> | C <sub>2</sub> | C <sub>3</sub> | C <sub>4</sub> | C <sub>5</sub> | C <sub>6</sub> | ±D    |
|------------------------|--------------------------|---------------|--------------|-----------|----------------|----------------|----------------|----------------|----------------|----------------|-------|
|                        |                          | Width** (CDC) | Max*** Crush |           |                |                |                |                |                |                |       |
|                        | Maximum Crush            |               |              |           | 0              | 4.5            | 35.8           | 33.0           | 30.0           | 0              |       |
|                        | Freospace                |               |              |           | -              | 0.8            | 0.8            | 0.8            | 0.8            | -              |       |
| A                      | Net Max. Crush           |               |              |           | 0              | 3.7            | 35.0           | 29.2           | 29.2           | 0              |       |
|                        | Sill Crush               |               |              |           | -              | -              | 14.2           | 16.5           | 16.5           | -              |       |
|                        | Sill Freespace           |               |              |           | -              | -              | 3.5            | 3.5            | 3.5            | -              |       |
| B                      | Net Sill Crush           |               |              |           | -              | -              | 10.7           | 13.0           | 13.0           | -              |       |
| C                      | Bowing                   |               |              |           | 7.0            | 7.0            | 7.0            | 7.0            | 7.0            | 7.0            |       |
| $\frac{A+B}{2} + C$    | Net Crush                |               |              | 97.0      | 7.0            | 10.7           | 29.9           | 28.1           | 28.1           | 7.0            | -14.4 |

\*Identify the plane at which the C-measurements are taken (e.g., at bumper, above bumper, at sill, above sill, at beltline, etc.) or label adjustments (e.g., free space).

Free space value is defined as the distance between the baseline and the original body contour taken at the individual C locations. This may include the following: bumper lead, bumper taper, side protrusion, side taper, etc. Record the value for each C-measurement and maximum crush.

\*\*Measure and document on the vehicle diagram the beginning or end of the direct damage width and field L (e.g., side damage with respect to undamaged axle.)

\*\*\*Measure and document on the vehicle diagram the location of the maximum crush.

Note: Use as many lines/columns as necessary to describe each damage profile.

## National Accident Sampling System — Continuous Sampling Subsystem: Vehicle Data

## FIELD MEASUREMENTS

Citation (compartment) - 25 mph  
smallest L

NCI

| Complete When Applicable   |                                       |
|----------------------------|---------------------------------------|
| End Damage                 | Side Damage                           |
| Undeformed end width _____ | Bowing: B1 _____ X1 <u>2.5</u>        |
| Corner shift: A1 _____     | B2 _____ X2 <u>16.0</u>               |
| A2 _____                   | Bowing constant                       |
| End shift at frame (CDC)   | $\frac{X1 + X2}{2} = \underline{9.3}$ |
| (check one)                |                                       |
| <4 inches _____            |                                       |
| ≥4 inches <u>X</u>         |                                       |

Note: Measure C1 to C6 from Driver to Passenger side in Front or Rear impacts-  
Rear to Front in Side impacts.

| Specific Impact Number | Plane* of C-Measurements | Direct Damage |              | Field L** | C <sub>1</sub> | C <sub>2</sub> | C <sub>3</sub> | C <sub>4</sub> | C <sub>5</sub> | C <sub>6</sub> | ±D    |
|------------------------|--------------------------|---------------|--------------|-----------|----------------|----------------|----------------|----------------|----------------|----------------|-------|
|                        |                          | Width** (CDC) | Max*** Crush |           |                |                |                |                |                |                |       |
|                        | Maximum Crush            |               |              |           | 0              | 3.5            | 33.7           | 31.0           | 26.6           | 0              |       |
|                        | Freospace                |               |              |           | -              | 0.8            | 0.8            | 0.8            | 0.8            | -              |       |
| A                      | Net Max. Crush           |               |              |           | 0              | 2.7            | 32.9           | 30.2           | 25.8           | 0              |       |
|                        | Sill Crush               |               |              |           | -              | -              | 10.6           | 15.6           | 17.0           | -              |       |
|                        | Sill Freespace           |               |              |           | -              | -              | 6.0            | 8.0            | 8.0            | -              |       |
| B                      | Net Sill Crush           |               |              |           | -              | -              | 4.6            | 7.6            | 9.0            | -              |       |
| C                      | Bowing                   |               |              |           | 9.3            | 9.3            | 9.3            | 9.3            | 9.3            | 9.3            |       |
| $\frac{A+B}{2} + C$    | Net Crush                |               |              | 91.5      | 9.3            | 12.0           | 28.1           | 28.2           | 26.7           | 9.3            | -21.9 |

\*Identify the plane at which the C-measurements are taken (e.g., at bumper, above bumper, at sill, above sill, at beltline, etc.) or label adjustments (e.g., free space).

Free space value is defined as the distance between the baseline and the original body contour taken at the individual C locations. This may include the following: bumper lead, bumper taper, side protrusion, side taper, etc. Record the value for each C-measurement and maximum crush.

\*\*Measure and document on the vehicle diagram the beginning or end of the direct damage width and field L (e.g., side damage with respect to undamaged axle.)

\*\*\*Measure and document on the vehicle diagram the location of the maximum crush.

Note: Use as many lines/columns as necessary to describe each damage profile.

## National Accident Sampling System — Continuous Sampling Subsystem: Vehicle Data

## FIELD MEASUREMENTS

Citation (compartment) - 25 mph  
largest L

NCI

Complete When Applicable

| End Damage                 | Side Damage                           |
|----------------------------|---------------------------------------|
| Undeformed end width _____ | Bowing: B1 _____ X1 <u>1.7</u>        |
| Corner shift: A1 _____     | B2 _____ X2 <u>2.3</u>                |
| A2 _____                   | Bowing constant                       |
| End shift at frame (CDC)   | $\frac{X1 + X2}{2} = \underline{2.0}$ |
| (check one)                |                                       |
| <4 inches _____            |                                       |
| ≥4 inches <u>X</u>         |                                       |

Note: Measure C1 to C6 from Driver to Passenger side in Front or Rear impacts-  
Rear to Front in Side impacts.

| Specific Impact Number | Plane* of C-Measurements | Direct Damage |              | Field L** | C <sub>1</sub> | C <sub>2</sub> | C <sub>3</sub> | C <sub>4</sub> | C <sub>5</sub> | C <sub>6</sub> | ±D   |
|------------------------|--------------------------|---------------|--------------|-----------|----------------|----------------|----------------|----------------|----------------|----------------|------|
|                        |                          | Width** (CDC) | Max*** Crush |           |                |                |                |                |                |                |      |
|                        | Maximum Crush            |               |              |           | 0              | 39.0           | 39.3           | 37.7           | 11.0           | 0              |      |
|                        | Freospace                |               |              |           | -              | 0.8            | 0.8            | 0.8            | 0.8            | -              |      |
| A                      | Net Max. Crush           |               |              |           | 0              | 38.2           | 38.5           | 36.9           | 10.2           | 0              |      |
|                        | Sill Crush               |               |              |           | -              | 8.9            | 23.3           | 28.4           | -              | -              |      |
|                        | Sill Freespace           |               |              |           | -              | 6.0            | 8.0            | 8.0            | -              | -              |      |
| B                      | Net Sill Crush           |               |              |           | -              | 2.9            | 15.3           | 20.4           | -              | -              |      |
| C                      | Bowing                   |               |              |           | 2.0            | 2.0            | 2.0            | 2.0            | 2.0            | 2.0            |      |
| $\frac{A+B}{2}+C$      | Net Crush                |               |              | 116.5     | 2.0            | 22.6           | 28.9           | 30.7           | 12.2           | 2.0            | -9.9 |

\*Identify the plane at which the C-measurements are taken (e.g., at bumper, above bumper, at sill, above sill, at beltline, etc.) or label adjustments (e.g., free space).

Free space value is defined as the distance between the baseline and the original body contour taken at the individual C locations. This may include the following: bumper lead, bumper taper, side protrusion, side taper, etc. Record the value for each C-measurement and maximum crush.

\*\*Measure and document on the vehicle diagram the beginning or end of the direct damage width and field L (e.g., side damage with respect to undamaged axle.)

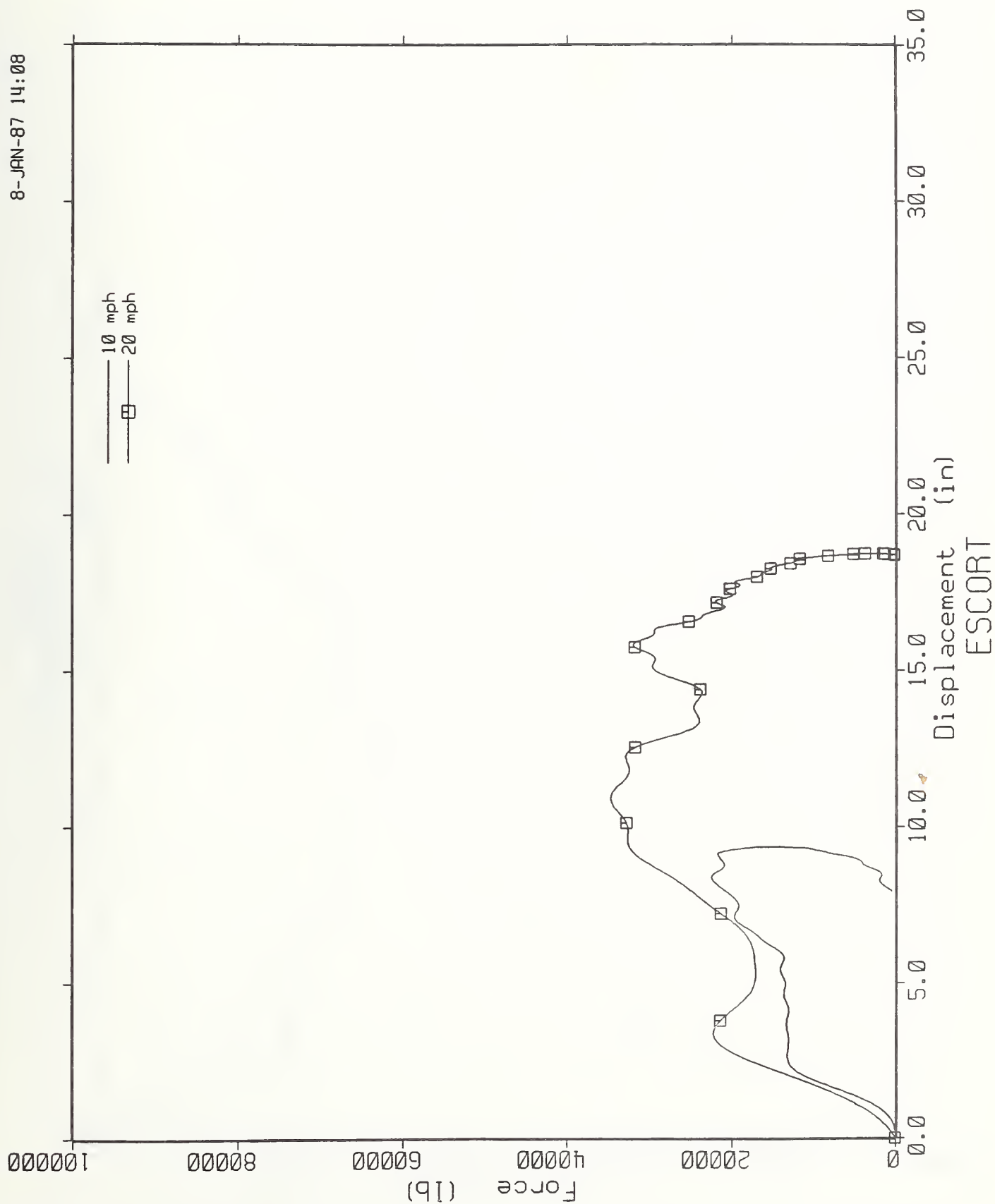
\*\*\*Measure and document on the vehicle diagram the location of the maximum crush.

Note: Use as many lines/columns as necessary to describe each damage profile.

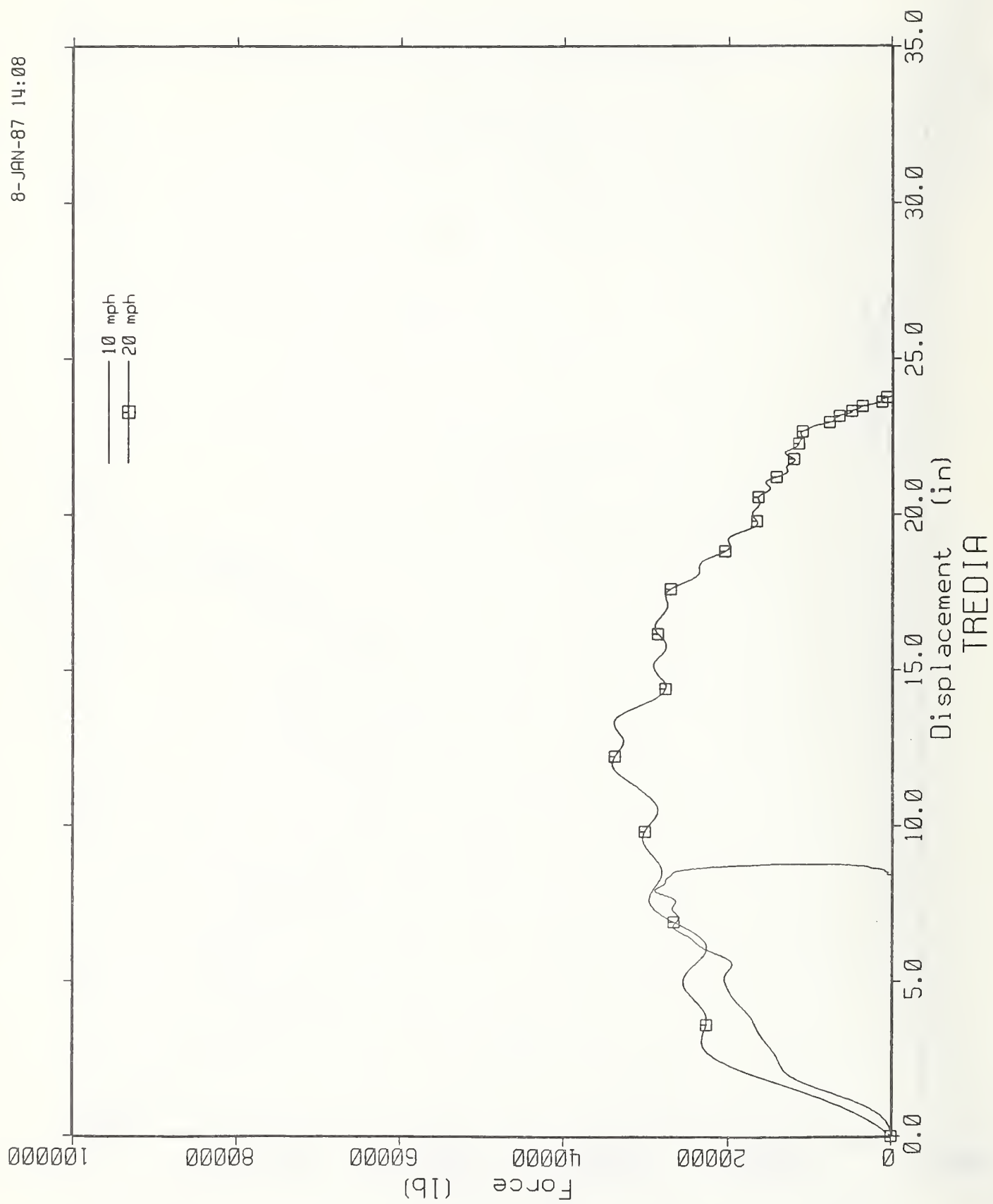
## APPENDIX B

### Side Impact Force vs. Deflection Plots

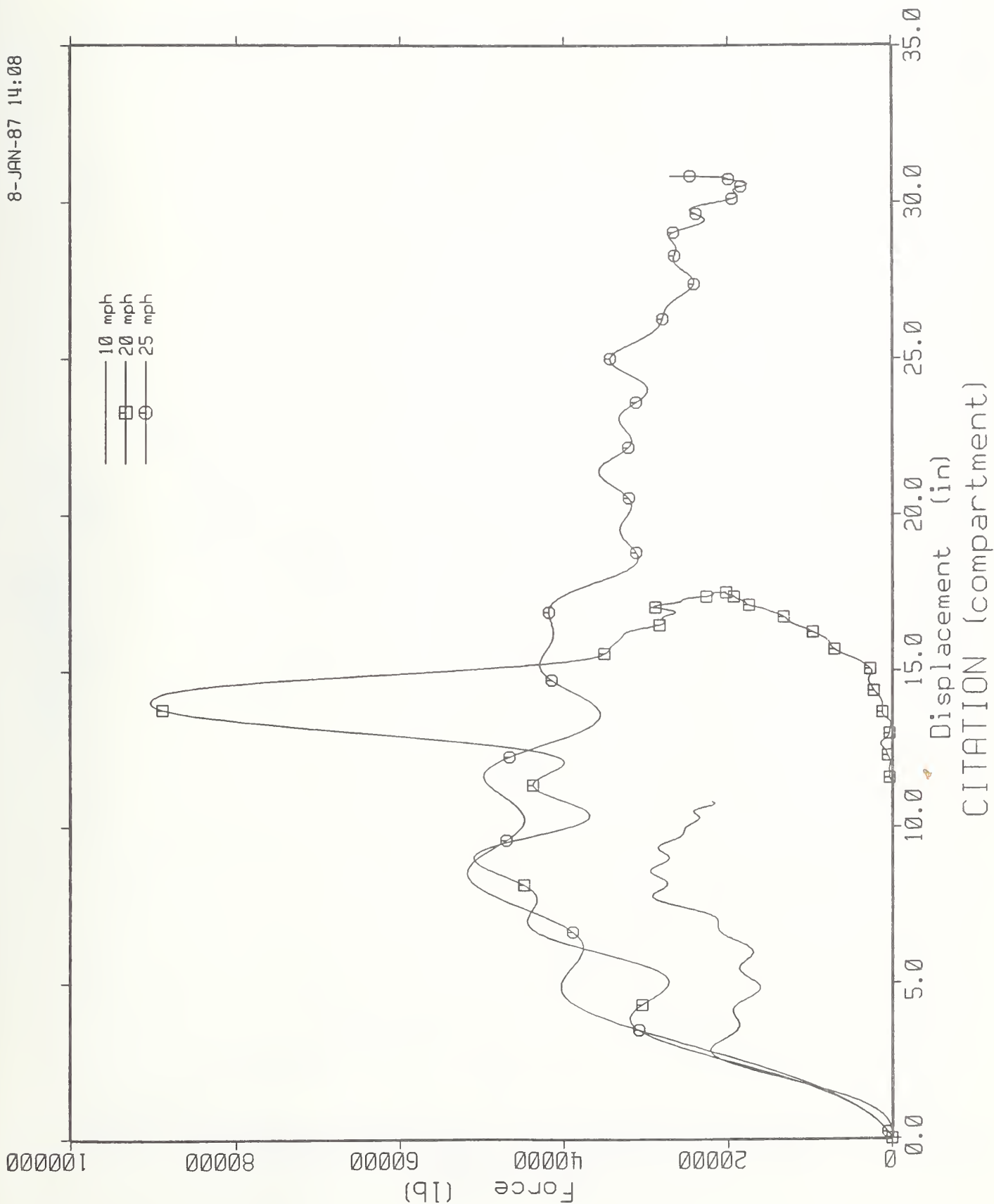
8-JAN-87 14:08



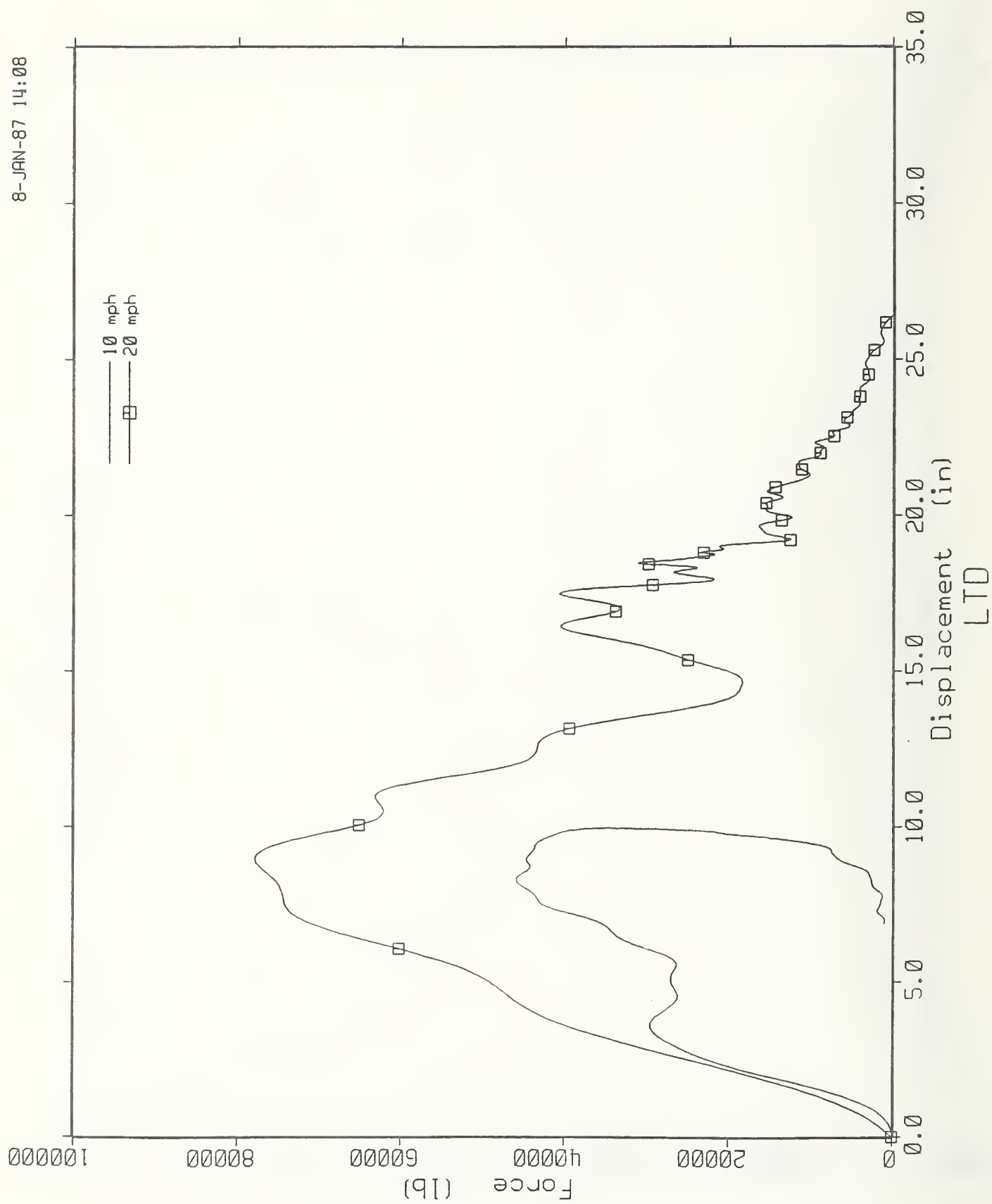
8-JAN-87 14:08



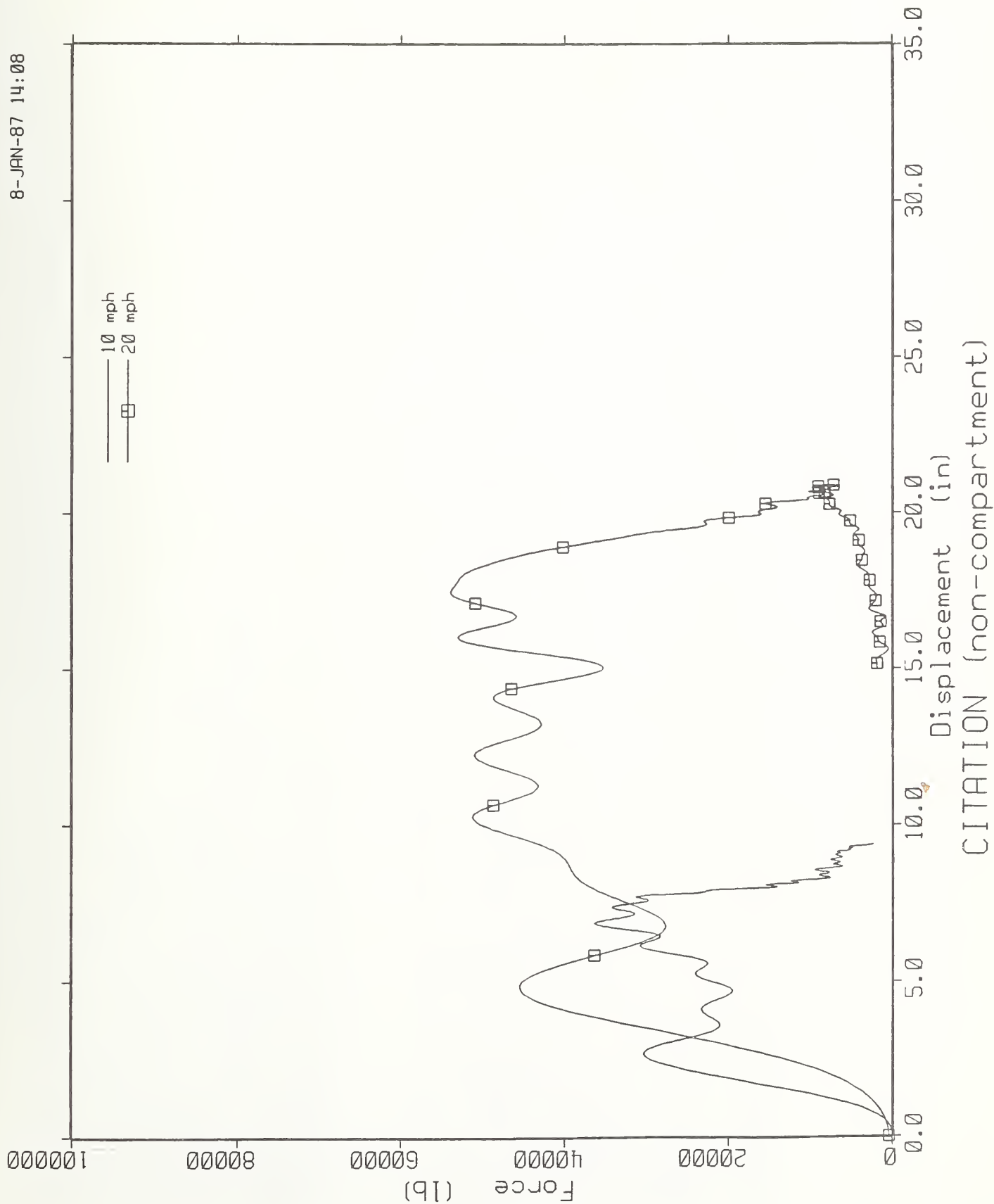
8-JAN-87 14:08



8-JAN-87 14:08



8-JAN-87 14:08



## APPENDIX C

### Side Impact CRUSH Runs

Title: ESCORT - LOW SPEED - D=COG

Size category vehicle no. 1: 1  
Size category vehicle no. 2: 7  
Weight of vehicle no. 1: 1985  
Weight of vehicle no. 2: 3237  
Vehicle damage indice no. 1: 09LDEW2  
Vehicle damage indice no. 2: 12FDEW2\2\1  
Impact speed vehicle no. 1 (mph): 0  
Impact speed vehicle no. 2 (mph): 16.1  
Direction of principal force for vehicle no. 1: 270  
Direction of principal force for vehicle no. 2: 360  
Damage width for vehicle no. 1: 75  
Number of damage depth profiles for vehicle no. 1 (2,4, or 6): 6  
Damage depth profile for vehicle no. 1: 0,5,3,5,2,5,6,5,2,0  
Damage midpoint offset for vehicle no. 1: -13.1  
Damage width for vehicle no. 2: 0  
Number of damage depth profiles for vehicle no. 2 (2,4, or 6): 2  
Damage depth profile for vehicle no. 2: 0,0  
Damage midpoint offset for vehicle no. 2: 0

==== INPUT DATA AND CRUSH ROUTINE RESULTS =====

ESCORT - LOW SPEED - D=COG  
VEHICLE TYPES: 1 7  
VEHICLE WEIGHTS: 1985.00 3237.00  
VEHICLE DAMAGE INDICES: 09LDEW2 12FDEW1  
COLLISION SPEEDS: 0.00 283.36  
A(2),E(2),G(2): 0.00 0.00  
DIRECTION OF PRINCIPAL FORCE: 270.00 360.00  
V1 DAMAGE DATA: 75.00 5.30  
V2 DAMAGE DATA: 0.00 0.00  
GAM(1;2): 0.92 1.00  
ENERGY(2): 0.00  
DELV1: 166.85  
SUMENG: 121437.43  
ENERGY(1): 121437.43  
ALPHA1,BETA1: 319.50 782.15

Do you want this data entered into your data set  
to calculate A and B values (Y/N)? N  
Run again (Y/N)? Y

5.20 0.00  
0.00 0.00  
-13.06 0.00

Title: TREDIA - LOW SPEED - =DCOG  
 Size category vehicle no. 1: 2  
 Size category vehicle no. 2: 7  
 Weight of vehicle no. 1: 2161  
 Weight of vehicle no. 2: 3237  
 Vehicle damage indice no. 1: 09LDEW2  
 Vehicle damage indice no. 2: 12FDEW1  
 Impact speed vehicle no. 1 (mph): 0  
 Impact speed vehicle no. 2 (mph): 16.7  
 Direction of principal force for vehicle no. 1: 270  
 Direction of principal force for vehicle no. 2: 360  
 Damage width for vehicle no. 1: 80  
 Number of damage depth profiles for vehicle no. 1 (2,4, or 6): 6  
 Damage depth profile for vehicle no. 1: 0,4,2,4,2,5,0,5,5,0  
 Damage midpoint offset for vehicle no. 1: -14.8  
 Damage width for vehicle no. 2: 0  
 Number of damage depth profiles for vehicle no. 2 (2,4, or 6): 2  
 Damage depth profile for vehicle no. 2: 0,0  
 Damage midpoint offset for vehicle no. 2: 0

===== INPUT DATA AND CRUSH ROUTINE RESULTS =====

TREDIA - LOW SPEED - =DCOG  
 VEHICLE TYPES : 2 7  
 VEHICLE WEIGHTS: 2161.00 3237.00  
 VEHICLE DAMAGE INDICES: 09LDEW2 12FDEW1  
 COLLISION SPEEDS: 0.00 293.92  
 A(2),B(2),G(2): 0.00 0.00 0.00  
 DIRECTION OF PRINCIPAL FORCE: 270.00 360.00  
 V1 DAMAGE DATA: 80.00 0.00 4.20  
 V2 DAMAGE DATA: 0.00 0.00 0.00  
 GAM(1;2): 0.95 1.00  
 ENERGY(2): 0.00  
 DELV1: 170.57  
 SUMENG: 140187.16  
 ENERGY(1): 140187.16  
 ALPHA1,BETA1: 302.40 659.20

5.50 0.00 0.00  
4.20 0.00 0.00  
-12.81 0.00

Do you want this data entered into your data set  
 to calculate A and B values (Y/N)? N  
 Run again (Y/N)? Y

# Title: CITATION - LOW SPEED - D=COG

Size category vehicle no. 1: 3  
Size category vehicle no. 2: 7  
Weight of vehicle no. 1: 2784  
Weight of vehicle no. 2: 3229  
Vehicle damage indice no. 1: 09LDEW2  
Vehicle damage indice no. 2: 12FDEW1  
Impact speed vehicle no. 1 (mph): 0  
Impact speed vehicle no. 2 (mph): 18.5  
Direction of principal force for vehicle no. 1: 3\3\270  
Direction of principal force for vehicle no. 2: 340  
Damage width for vehicle no. 1: 78  
Number of damage depth profiles for vehicle no. 1 (2,4, or 6): 6  
Damage depth profile for vehicle no. 1: 0,9,1,8,6,8,7,8,3,0  
Damage midpoint offset for vehicle no. 1: 0\0\-11,1  
Damage width for vehicle no. 2: 0  
Number of damage depth profiles for vehicle no. 2 (2,4, or 6): 2  
Damage depth profile for vehicle no. 2: 0,0  
Damage midpoint offset for vehicle no. 2: 0

## ===== INPUT DATA AND CRUSH ROUTINE RESULTS =====

CITATION - LOW SPEED - D=COG  
VEHICLE TYPES: 3 7  
VEHICLE WEIGHTS: 2784.00 3229.00  
VEHICLE DAMAGE INDICES: 09LDEW2 12FDEW1  
COLLISION SPEEDS: 0.00 325.60  
A(2),E(2),G(2): 0.00 0.00  
DIRECTION OF PRINCIPAL FORCE: 270.00 360.00  
V1 DAMAGE DATA: 78.00 0.00 9.10  
V2 DAMAGE DATA: 0.00 0.00 0.00  
GAM(1;2): 0.96 1.00  
ENERGY(2):  
DELV1: 171.12  
SUMENG: 200715.16  
ENERG(1): 200715.16  
ALPHA1,BETA1: 541.32 2152.78

8.30 0.00 0.00  
8.70 0.00 0.00  
-11.62 0.00

Do you want this data entered into your data set  
to calculate A and B values (Y/N)? N  
Run again (Y/N)? Y

```

Title: LTP - LOW SPEED - D=COG
Size category vehicle no. 1: 4
Size category vehicle no. 2: 7
Weight of vehicle no. 1: 3554
Weight of vehicle no. 2: 3237
Vehicle damage indice no. 1: 09LDEW2
Vehicle damage indice no. 2: 12FDEW1
Impact speed vehicle no. 1 (mph): 0
Impact speed vehicle no. 2 (mph): 20.9
Direction of principal force for vehicle no. 1: 270
Direction of principal force for vehicle no. 2: 360
Damage width for vehicle no. 1: 85.3
Number of damage depth profiles for vehicle no. 1 (2,4, or 6): 6
Damage depth profile for vehicle no. 1: 0.6,7,6,0,6,2,6,1,0
Damage midpoint offset for vehicle no. 1: -4.9
Damage width for vehicle no. 2: 0
Number of damage depth profiles for vehicle no. 2 (2,4, or 6): 2
Damage depth profile for vehicle no. 2: 0,0
Damage midpoint offset for vehicle no. 2: 0

```

==== INPUT DATA AND CRUSH ROUTINE RESULTS =====

```

LTD - LOW SPEED - D=COG
VEHICLE TYPES: 4 7
VEHICLE WEIGHTS: 3554.00 3237.00
VEHICLE DAMAGE INDICES: 09LDEW2 12FDEW1
COLLISION SPEEDS: 0.00 367.84
A(2),B(2),G(2): 0.00 0.00 0.00
DIRECTION OF PRINCIPAL FORCE: 270.00 360.00
V1 DAMAGE DATA: 85.30 0.00 6.70
V2 DAMAGE DATA: 0.00 0.00 0.00
GAM(1:2): 0.99 1.00
ENERGY(2): 0.00
DELVI: 174.67
SUMENG: 295487.09
ENERGY(1): 295487.09
ALPHA1,BETA1: 426.50 1217.80

```

Do you want this data entered into your data set  
to calculate A and B values (Y/N)? N  
Run again (Y/N)? Y

Title: N-COMP CITATION - LOW SPEED - D=COG  
 Size category vehicle no. 1: 3  
 Size category vehicle no. 2: 7  
 Weight of vehicle no. 1: 2602  
 Weight of vehicle no. 2: 3237  
 Vehicle damage indice no. 1: 09LDEW2  
 Vehicle damage indice no. 2: 12FDEW1  
 Impact speed vehicle no. 1 (mph): 0  
 Impact speed vehicle no. 2 (mph): 18.1  
 Direction of principal force for vehicle no. 1: 270  
 Direction of principal force for vehicle no. 2: 360  
 Damase width for vehicle no. 1: 67  
 Number of damase depth profiles for vehicle no. 1 (2,4, or 6): 6  
 Damase depth profile for vehicle no. 1: 2,7,6,2,6,2,5,8,3,9,1,4  
 Damase midpoint offset for vehicle no. 1: 13.5  
 Damase width for vehicle no. 2: 0  
 Number of damase depth profiles for vehicle no. 2 (2,4, or 6): 2  
 Damase depth profile for vehicle no. 2: 0,0  
 Damase midpoint offset for vehicle no. 2: 0

==== INPUT DATA AND CRUSH ROUTINE RESULTS ====

N-COMP CITATION - LOW SPEED - D=COG  
 VEHICLE TYPES : 3 7  
 VEHICLE WEIGHTS: 2602.00 3237.00  
 VEHICLE DAMAGE INDICES: 09LDEW2 12FDEW1  
 COLLISION SPEEDS: 0.00 318.56  
 A(2),B(2),G(2): 0.00 0.00 0.00  
 DIRECTION OF PRINCIPAL FORCE: 270.00 360.00  
 V1 DAMAGE DATA: 67.00 2.70 6.20  
 V2 DAMAGE DATA: 0.00 0.00 0.00  
 GAM(1,2): 0.97 1.00  
 ENERGY(2): 0.00  
 DELV1: 173.30  
 SUMENG: 185875.45  
 ENERGY(1): 185875.45  
 ALPHA1,BETA1: 323.61 848.51

3.90 1.40 10.69  
 0.00 0.00 0.00

Do you want this data entered into your data set  
 to calculate A and B values (Y/N)? N  
 Run again (Y/N)? N

Title: ESCORT - HI SPEED S.\.M. L - D-\-\\=COG  
 Size category vehicle no. 1: 1  
 Size category vehicle no. 2: 7  
 Weight of vehicle no. 1: 1985  
 Weight of vehicle no. 2: 3237  
 Vehicle damage indice no. 1: 03RDEW5  
 Vehicle damage indice no. 2: 12FDEW1  
 Impact speed vehicle no. 1 (mph): 0  
 Impact speed vehicle no. 2 (mph): 32.2  
 Direction of principal force for vehicle no. 1: 90  
 Direction of principal force for vehicle no. 2: 360  
 Damage width for vehicle no. 1: 85  
 Number of damage depth profiles for vehicle no. 1 (2,4, or 6): 6  
 Damage depth profile for vehicle no. 1: 6.6,20.1,19.8,20.0,20.0,6.6  
 Damage midpoint offset for vehicle no. 1: -17.6  
 Damage width for vehicle no. 2: 0  
 Number of damage depth profiles for vehicle no. 2 (2,4, or 6): 2  
 Damage depth profile for vehicle no. 2: 0,0  
 Damage midpoint offset for vehicle no. 2: 0

==== INPUT DATA AND CRUSH ROUTINE RESULTS =====

ESCORT - HI SPEED SM. L - D=COG  
 VEHICLE TYPES : 1 7  
 VEHICLE WEIGHTS: 1985.00 3237.00  
 VEHICLE DAMAGE INDICES: 03RDEW5 12FDEW1  
 COLLISION SPEEDS: 0.00 566.72  
 A(2),B(2),G(2): 0.00 0.00 0.00  
 DIRECTION OF PRINCIPAL FORCE: 90.00 360.00  
 V1 DAMAGE DATA: 85.00 6.60 20.10 19.80 20.00 20.00 6.60  
 V2 DAMAGE DATA: 0.00 0.00 0.00 0.00 0.00 0.00 0.00  
 GAM(1;2): 0.87 1.00  
 ENERGY(2): 0.00  
 DELV1: 320.58  
 SUMENG: 466652.81  
 ENERGY(1): 466652.81  
 ALPHA1,BETA1: 1470.50 13423.94

Do you want this data entered into your data set  
 to calculate A and B values (Y/N)? N  
 Run again (Y/N)? Y

Title: ESCORT - HI SPEED - LG, L - D=C06

Size category vehicle no. 1: 1

Size category vehicle no. 2: 7

Weight of vehicle no. 1: 1985

Weight of vehicle no. 2: 3237

Vehicle damage indice no. 1: 03RDEWS

Vehicle damage indice no. 2: 12FDEW1

Impact speed vehicle no. 1 (mph): 0

Impact speed vehicle no. 2 (mph): 32.2

Direction of principal force for vehicle no. 1: 90

Direction of principal force for vehicle no. 2: 360

Damage width for vehicle no. 1: 102

Number of damage depth profiles for vehicle no. 1 (2,4, or 6): 6

Damage depth profile for vehicle no. 1: 3.2,19.0,19.2,19.7,19.6,3.2

Damage midpoint offset for vehicle no. 1: -14.6

Damage width for vehicle no. 2: 0

Number of damage depth profiles for vehicle no. 2 (2,4, or 6): 2

Damage depth profile for vehicle no. 2: 0,0

Damage midpoint offset for vehicle no. 2: 0

===== INPUT DATA AND CRUSH ROUTINE RESULTS =====

ESCORT - HI SPEED - LG, L - D=C06

VEHICLE TYPES: 1 7

VEHICLE WEIGHTS: 1985.00 3237.00

VEHICLE DAMAGE INDICES: 03RDEWS 12FDEW1

COLLISION SPEEDS: 0.00 566.72

A(2),B(2),G(2): 0.00 0.00 0.00

DIRECTION OF PRINCIPAL FORCE: 90.00 360.00

V1 DAMAGE DATA: 102.00 3.20 19.00

V2 DAMAGE DATA: 0.00 0.00 0.00

GAM(1,2): 0.90 1.00

ENERGY(2): 0.00

DELVI: 329.34

SUNENG: 479403.91

ENERGY(1): 479403.91

ALPHA1,BETA1: 1625.89 14203.98

Do you want this data entered into your data set  
to calculate A and B values (Y/N)? N  
Run again (Y/N)? Y

19.20 19.70 18.60 3.20 -14.69  
0.00 0.00 0.00 0.00 0.00

Title: TREDIA - HI SPEED - SM, L - D=COG

Size category vehicle no. 1: 2  
 Size category vehicle no. 2: 7  
 Weight of vehicle no. 1: 2161  
 Weight of vehicle no. 2: 3237  
 Vehicle damage indice no. 1: 03RDEWS  
 Vehicle damage indice no. 2: 12FDEW1  
 Impact speed vehicle no. 1 (mph): 0  
 Impact speed vehicle no. 2 (mph): 33.5  
 Direction of principal force for vehicle no. 1: 90  
 Direction of principal force for vehicle no. 2: 360  
 Damage width for vehicle no. 1: 81  
 Number of damage depth profiles for vehicle no. 1 (2,4, or 6): 6  
 Damage depth profile for vehicle no. 1: 4,1,14,4,15,7,14,7,13,5,4,1  
 Damage midpoint offset for vehicle no. 1: -15.8  
 Damage width for vehicle no. 2: 0  
 Number of damage depth profiles for vehicle no. 2 (2,4, or 6): 2  
 Damage depth profile for vehicle no. 2: 0,0  
 Damage midpoint offset for vehicle no. 2: 0

==== INPUT DATA AND CRUSH ROUTINE RESULTS =====

TREDIA - HI SPEED - SM, L - D=COG  
 VEHICLE TYPES : 2 7  
 VEHICLE WEIGHTS: 2161.00 3237.00  
 VEHICLE DAMAGE INDICES: 03RDEWS 12FDEW1  
 COLLISION SPEEDS: 0.00 589.60  
 A(2),B(2),G(2): 0.00 0.00 0.00  
 DIRECTION OF PRINCIPAL FORCE: 90.00 360.00  
 V1 DAMAGE DATA: 81.00 4.10 14.40  
 V2 DAMAGE DATA: 0.00 0.00 0.00  
 GAM(1;2): 0.92 1.00  
 ENERGY(2):  
 DELV1: 335.49  
 SUMENG: 553132.25  
 ENERGY(1): 553132.25  
 ALPHA1,RETA1: 1010.88 6770.82

Do you want this data entered into your data set  
 to calculate A and B values (Y/N)? N  
 Run again (Y/N)? Y

Title: TREDIA - HI SPEED - LG, L - D=COG  
 Size category vehicle no. 1: 2  
 Size category vehicle no. 2: 7  
 Weight of vehicle no. 1: 2161  
 Weight of vehicle no. 2: 3237  
 Vehicle damage indice no. 1: 03RDEW5  
 Vehicle damage indice no. 2: 12FDEW1  
 Impact speed vehicle no. 1 (mph): 0  
 Impact speed vehicle no. 2 (mph): 33.5  
 Direction of principal force for vehicle no. 1: 90  
 Direction of principal force for vehicle no. 2: 360  
 Damage width for vehicle no. 1: 99.5  
 Number of damage depth profiles for vehicle no. 1 (2,4, or 6): 6  
 Damage depth profile for vehicle no. 1: 0.7,11.9,16.0,14.4,13.3,0.7  
 Damage midpoint offset for vehicle no. 1: -12.9  
 Damage width for vehicle no. 2: 0  
 Number of damage depth profiles for vehicle no. 2 (2,4, or 6): 2  
 Damage depth profile for vehicle no. 2: 0.0  
 Damage midpoint offset for vehicle no. 2: 0

===== INPUT DATA AND CRUSH ROUTINE RESULTS =====

TREDIA - HI SPEED - LG, L - D=COG  
 VEHICLE TYPES: 2 7  
 VEHICLE WEIGHTS: 2161.00 3237.00  
 VEHICLE DAMAGE INDICES: 03RDEW5 12FDEW1  
 COLLISION SPEEDS: 0.00 589.60  
 A(2),B(2),G(2): 0.00 0.00  
 DIRECTION OF PRINCIPAL FORCE: 90.00 360.00  
 V1 DAMAGE DATA: 99.50 0.70 11.90  
 V2 DAMAGE DATA: 0.00 0.00 0.00  
 GAM(1;2): 0.95 1.00  
 ENERGY(2): 0.00  
 DELV1: 342.95  
 SUMENG: 565426.13  
 ENERGY(1): 565426.13  
 ALPHA1,BETA1: 1120.37 7278.96

16.00 14.40 13.30 0.70 -12.34  
 0.00 0.00 0.00 0.00 0.00

Do you want this data entered into your data set  
 to calculate A and B values (Y/N)? N  
 Run again (Y/N)? Y

Title: CITATION - HI SPEED - SM. L - D=COG

Size category vehicle no. 1: 3

Size category vehicle no. 2: 7

Weight of vehicle no. 1: 2420

Weight of vehicle no. 2: 3168

Vehicle damage indice no. 1: 09LDEW5

Vehicle damage indice no. 2: 12FDEW1

Impact speed vehicle no. 1 (mph): 0

Impact speed vehicle no. 2 (mph): 35.2

Direction of principal force for vehicle no. 1: 270

Direction of principal force for vehicle no. 2: 360

Damage width for vehicle no. 1: 81.5

Number of damage depth profiles for vehicle no. 1 (2,4, or 6): 6

Damage depth profile for vehicle no. 1: 5.2,19.6,18.1,16.9,17.0,5.2

Damage midpoint offset for vehicle no. 1: -9.5\5.9-\-15.0

Damage width for vehicle no. 2: 0

Number of damage depth profiles for vehicle no. 2 (2,4, or 6): 2

Damage depth profile for vehicle no. 2: 0,0

Damage midpoint offset for vehicle no. 2: 0

==== INPUT DATA AND CRUSH ROUTINE RESULTS =====

CITATION -- HI SPEED - SM. L -- D=COG

VEHICLE TYPES : 3 7

VEHICLE WEIGHTS: 2420.00 3168.00

VEHICLE DAMAGE INDICES: 09LDEW5 12FDEW1

COLLISION SPEEDS: 0.00 619.52

A(2),B(2),G(2): 0.00 0.00 0.00

DIRECTION OF PRINCIPAL FORCE: 270.00 360.00

V1 DAMAGE DATA: 81.50 5.20 19.60

V2 DAMAGE DATA: 0.00 0.00 0.00

GAM(1:2): 0.93 1.00

ENERGY(2): 0.00

DELVI: 336.61

SUMENG: 653023.81

ENERGY(1): 653023.81

ALPHA1,BETA1: 1251.84 10238.55

18.10 16.90 5.20 -15.96  
0.00 0.00 0.00 0.00

Do you want this data entered into your data set  
to calculate A and B values (Y/N)? N  
Run again (Y/N)? Y

TITLE: COLLISION - HI SPEED - LG. L - D=C06  
 Size category vehicle no. 1: 3 \  
 Size category vehicle no. 2: 7  
 Weight of vehicle no. 1: 2429\9\0  
 Weight of vehicle no. 2: 3168  
 Vehicle damage indice no. 1: 09LDEW5  
 Vehicle damage indice no. 2: 12FDEW1  
 Impact speed vehicle no. 1 (mph): 0  
 Impact speed vehicle no. 2 (mph): 35.2  
 Direction of principal force for vehicle no. 1: 270  
 Direction of principal force for vehicle no. 2: 360  
 Damage width for vehicle no. 1: 100  
 Number of damage depth profiles for vehicle no. 1 (2,4, or 6): 6  
 Damage depth profile for vehicle no. 1: 1,8,17,5,17,0,17,5,10,0,1,8  
 Damage midpoint offset for vehicle no. 1: -9,5  
 Damage width for vehicle no. 2: 0  
 Number of damage depth profiles for vehicle no. 2 (2,4, or 6): 2  
 Damage depth profile for vehicle no. 2: 0,0  
 Damage midpoint offset for vehicle no. 2: 0

===== INPUT DATA AND CRUSH ROUTINE RESULTS =====

CITATION - HI SPEED - LG. L - D=C06  
 VEHICLE TYPES : 3 7  
 VEHICLE WEIGHTS: 2420.00 3168.00  
 VEHICLE DAMAGE INDICES: 09LDEW5 12FDEW1  
 COLLISION SPEEDS: 0.00 619.52  
 A(2),B(2),G(2): 0.00 0.00 0.00  
 DIRECTION OF PRINCIPAL FORCE: 270.00 360.00  
 V1 DAMAGE DATA: 100.00 1.80 17.50  
 V2 DAMAGE DATA: 0.00 0.00 0.00  
 GAM(1,2): 0.95 1.00  
 ENERGY(2): 0.00  
 DELV1: 341.46  
 SUMENG: 622434.06  
 ENERGY(1): 652434.06  
 ALPHA1,BETA1: 1276.00 9429.93

17.00 17.50 10.00 1.80  
 0.00 0.00 0.00 0.00  
 -12.95  
 0.00

Do you want this data entered into your data set  
 to calculate A and B values (Y/N)? N  
 Run again (Y/N)? Y

Title: LID - HI SPEED - SM, L - D=COG  
 Size category vehicle no. 1: 4  
 Size category vehicle no. 2: 7  
 Weight of vehicle no. 1: 255\552\3554  
 Weight of vehicle no. 2: 3237  
 Vehicle damage indice no. 1: 03RDEW5  
 Vehicle damage indice no. 2: 12FDEW1  
 Impact speed vehicle no. 1 (mph): 0  
 Impact speed vehicle no. 2 (mph): 42.1  
 Direction of principal force for vehicle no. 1: 90  
 Direction of principal force for vehicle no. 2: 360  
 Damage width for vehicle no. 1: 111.5  
 Number of damage depth profiles for vehicle no. 1 (2,4, or 6): 6  
 Damage depth profile for vehicle no. 1: 4.1,18.9,20.5,14.8,17.9,4.1  
 Damage midpoint offset for vehicle no. 1: -1.2  
 Damage width for vehicle no. 2: 0  
 Number of damage depth profiles for vehicle no. 2 (2,4, or 6): 2  
 Damage depth profile for vehicle no. 2: 0,0  
 Damage midpoint offset for vehicle no. 2: 0

--- INPUT DATA AND CRUSH ROUTINE RESULTS ===

LID - HI SPEED - SM, L - D=COG  
 VEHICLE TYPES : 4 /  
 VEHICLE WEIGHTS: 3554.00 3237.00  
 VEHICLE DAMAGE INDICES: 03RDEW5 12FDEW1  
 COLLISION SPEEDS: 0.00 740.96  
 A(2),R(2),G(2): 0.00 0.00 0.00  
 DIRECTION OF PRINCIPAL FORCE: 90.00 360.00  
 V1 DAMAGE DATA: 111.50 4.10 18.90  
 V2 DAMAGE DATA: 0.00 0.00 0.00  
 GAM(1:2): 1.00 1.00  
 ENERGY(2): 0.00  
 DELV1: 352.91  
 SUMENG: 1202568.88  
 ENERGY(1): 1202568.88  
 ALPHA1,BETA1: 1697.26 14027.03

Do you want this data entered into your data set  
 to calculate A and B values (Y/N)? N  
 Run again (Y/N)? Y

```

Title: LID - HI SPEED - LG, L - D-COG
Size category vehicle no. 1: 4
Size category vehicle no. 2: 7
Weight of vehicle no. 1: 3554
Weight of vehicle no. 2: 3237
Vehicle damage indice no. 1: 03RDEW5
Vehicle damage indice no. 2: 12FDEW1
Impact speed vehicle no. 1 (mph): 0
Impact speed vehicle no. 2 (mph): 42.1
Direction of principal force for vehicle no. 1: 90
Direction of principal force for vehicle no. 2: 360
Damage width for vehicle no. 1: 138.5
Number of damage depth profiles for vehicle no. 1 (2,4, or 6): 6
Damage depth profile for vehicle no. 1: 1,0,8,2,21,1,14,7,12,4,1,0
Damage midpoint offset for vehicle no. 1: 0.1
Damage width for vehicle no. 2: 0
Number of damage depth profiles for vehicle no. 2 (2,4, or 6): 2
Damage depth profile for vehicle no. 2: 0,0
Damage midpoint offset for vehicle no. 2: 0

```

===== INPUT DATA AND CRUSH ROUTINE RESULTS =====

```

LID - HI SPEED - LG, L - D-COG
VEHICLE TYPES: 4 7
VEHICLE WEIGHTS: 3554.00 3237.00
VEHICLE DAMAGE INDICES: 03RDEW5 12FDEW1
COLLISION SPEEDS: 0.00 740.96
A(2),E(2),G(2): 0.00 0.00 0.00
DIRECTION OF PRINCIPAL FORCE: 90.00 360.00
V1 DAMAGE DATA: 128.50 1.00 8.20
V2 DAMAGE DATA: 0.00 0.00 0.00
GAM(1,2): 1.00 1.00
ENERGY(2):
DELTA: 353.07
SUMENG: 1203115.50
ENERGY(1): 1203115.50
ALPHA1,BETA1: 1589.98 11323.16

```

Do you want this data entered into your data set  
to calculate A and E values (Y/N)? N  
Run again (Y/N)? Y

Title: N-COMP CITATION - HI SPEED - SM, L - D-COG

Size category vehicle no. 1: 3  
 Size category vehicle no. 2: 7  
 Weight of vehicle no. 1: 2602  
 Weight of vehicle no. 2: 3237  
 Vehicle damage indice no. 1: 03RYEW5  
 Vehicle damage indice no. 2: 12FDEW1  
 Impact speed vehicle no. 1 (mph): 0  
 Impact speed vehicle no. 2 (mph): 36.0  
 Direction of principal force for vehicle no. 1: 0\0\90  
 Direction of principal force for vehicle no. 2: 360  
 Damage width for vehicle no. 1: 107.5  
 Number of damage depth profiles for vehicle no. 1 (2,4, or 6): 6  
 Damage depth profile for vehicle no. 1: 0,5,1,16,0,12,2,6,9,0  
 Damage midpoint offset for vehicle no. 1: 8.5  
 Damage width for vehicle no. 2: 0  
 Number of damage depth profiles for vehicle no. 2 (2,4, or 6): 2  
 Damage depth profile for vehicle no. 2: 0,0  
 Damage midpoint offset for vehicle no. 2: 0

# ===== INPUT DATA AND CRUSH ROUTINE RESULTS =====

N-COMP CITATION - HI SPEED - SM, L - D=C

|                               |           |         |        |       |       |      |      |
|-------------------------------|-----------|---------|--------|-------|-------|------|------|
| VEHICLE TYPES:                | 3         | 7       |        |       |       |      |      |
| VEHICLE WEIGHTS:              | 2602.00   | 3237.00 |        |       |       |      |      |
| VEHICLE DAMAGE INDICES:       | 03RYEW5   | 12FDEW1 |        |       |       |      |      |
| COLLISION SPEEDS:             | 0.00      | 633.60  |        |       |       |      |      |
| A(2),E(2),G(2):               | 0.00      | 0.00    | 0.00   |       |       |      |      |
| DIRECTION OF PRINCIPAL FORCE: |           | 90.00   | 360.00 |       |       |      |      |
| V1 DAMAGE DATA:               | 107.50    | 0.00    | 5.10   |       |       |      |      |
| V2 DAMAGE DATA:               | 0.00      | 0.00    | 0.00   | 16.00 | 12.20 | 6.90 | 8.93 |
| GAM(1;2):                     | 0.98      | 1.00    |        | 0.00  | 0.00  |      | 0.00 |
| ENERGY(2):                    |           |         |        |       |       |      |      |
| DELVI:                        | 346.64    |         |        |       |       |      |      |
| SUMENG:                       | 739501.25 |         |        |       |       |      |      |
| ENERGY(1):                    | 739501.25 |         |        |       |       |      |      |
| ALPHA1,BETA1:                 | 864.30    | 4722.48 |        |       |       |      |      |

Do you want this data entered into your data set  
 to calculate A and B values (Y/N)? N  
 Run again (Y/N)? Y

Title: N-COMP CITATION - HI SPEED - LG. L - D-COG  
 Size category vehicle no. 1: 3  
 Size category vehicle no. 2: 7  
 Weight of vehicle no. 1: 2602  
 Weight of vehicle no. 2: 3237  
 Vehicle damage indice no. 1: 03RYEW5  
 Vehicle damage indice no. 2: 12FDEW1  
 Impact speed vehicle no. 1 (mph): 0  
 Impact speed vehicle no. 2 (mph): 36.0  
 Direction of principal force for vehicle no. 1: 90  
 Direction of principal force for vehicle no. 2: 360  
 Damage width for vehicle no. 1: 120  
 Number of damage depth profiles for vehicle no. 1 (2,4, or 6): 6  
 Damage depth profile for vehicle no. 1: 0,2,7,17,6,13,8,7,4,0  
 Damage midpoint offset for vehicle no. 1: 5.3  
 Damage width for vehicle no. 2: 0  
 Number of damage depth profiles for vehicle no. 2 (2,4, or 6): 2  
 Damage depth profile for vehicle no. 2: 0,0  
 Damage midpoint offset for vehicle no. 2: 0

# INPUT DATA AND CRUSH ROUTINE RESULTS

N-COMP CITATION - HI SPEED - LG. L - D-C  
 VEHICLE TYPES: 3 7  
 VEHICLE WEIGHTS: 2602.00 3237.00  
 VEHICLE DAMAGE INDICES: 03RYEW5 12FDEW1  
 COLLISION SPEEDS: 0.00 673.60  
 A(2),E(2),G(2): 0.00 0.00 0.00  
 DIRECTION OF PRINCIPAL FORCE: 90.00 360.00  
 V1 DAMAGE DATA: 120.00 0.00 2.70  
 V2 DAMAGE DATA: 0.00 0.00 0.00  
 GOM(1,2): 0.98 1.00  
 ENERGY(2): 0.00  
 DELV1: 347.28  
 SUMENG: 740864.13  
 ENERGY(1): 740864.13  
 ALPHA1,BETA1: 996.00 6068.08

Do you want this data entered into your data set  
 to calculate A and E values (Y/N)? N  
 Run again (Y/N)? Y

17.60 13.80 7.40 8.28  
 0.00 0.00 0.00 0.00

Title: 25 MPH CITATION - VRTC - D=C06

Size category vehicle no. 1: 3  
 Size category vehicle no. 2: 7  
 Weight of vehicle no. 1: 2784  
 Weight of vehicle no. 2: 3229  
 Vehicle damage index no. 1: 03KDEW5  
 Vehicle damage index no. 2: 12FDEM1  
 Impact speed vehicle no. 1 (mph): 0  
 Impact speed vehicle no. 2 (mph): 46.6  
 Direction of principal force for vehicle no. 1: 90  
 Direction of principal force for vehicle no. 2: 360  
 Damage width for vehicle no. 1: 97  
 Number of damage depth profiles for vehicle no. 1 (2,4, or 6): 6  
 Damage depth profile for vehicle no. 1: 7.0,10.7,29.9,28.6,28.1,7.0  
 Damage midpoint offset for vehicle no. 1: -14.4  
 Damage width for vehicle no. 2: 0  
 Number of damage depth profiles for vehicle no. 2 (2,4, or 6): 2  
 Damage depth profile for vehicle no. 2: 0,0  
 Damage midpoint offset for vehicle no. 2: 0

==== INPUT DATA AND CRUSH ROUTINE RESULTS =====

25 MPH CITATION - VRTC - D=C06

|                               |            |          |        |  |  |  |  |
|-------------------------------|------------|----------|--------|--|--|--|--|
| VEHICLE TYPES:                | 3          | 7        |        |  |  |  |  |
| VEHICLE WEIGHTS:              | 2784.00    | 3229.00  |        |  |  |  |  |
| VEHICLE DAMAGE INDICES:       | 03KDEW5    | 12FDEM1  |        |  |  |  |  |
| COLLISION SPEEDS:             | 0.00       | 920.16   |        |  |  |  |  |
| G(2),R(2),G(2):               | 0.00       | 0.00     | 0.00   |  |  |  |  |
| DIRECTION OF PRINCIPAL FORCE: |            | 90.00    | 360.00 |  |  |  |  |
| V1 DAMAGE DATA:               | 97.00      | 7.00     | 10.70  |  |  |  |  |
| V2 DAMAGE DATA:               | 0.00       | 0.00     | 0.00   |  |  |  |  |
| GAM(1;2):                     | 0.97       | 1.00     |        |  |  |  |  |
| ENERGY(2):                    |            |          |        |  |  |  |  |
| DEL V1:                       | 433.88     |          |        |  |  |  |  |
| SUMENG:                       | 1281943.13 |          |        |  |  |  |  |
| ENERGY(1):                    | 1281943.13 |          |        |  |  |  |  |
| ALPHA1,DETA1:                 | 2023.42    | 24510.19 |        |  |  |  |  |

Do you want this data entered into your data set  
 to calculate A and B values (Y/N)? N  
 Run again (Y/N)? Y

File: 25 MPH CITATION - SM, L - D=COG  
 Size category vehicle no. 1: 3  
 Size category vehicle no. 2: 7  
 Weight of vehicle no. 1: 2784  
 Weight of vehicle no. 2: 3229  
 Vehicle damage indice no. 1: 03RDEW5  
 Vehicle damage indice no. 2: 12FDEW1  
 Impact speed vehicle no. 1 (mph): 0  
 Impact speed vehicle no. 2 (mph): 46.2  
 Direction of principal force for vehicle no. 1: 90  
 Direction of principal force for vehicle no. 2: 360  
 Damage width for vehicle no. 1: 91.5  
 Number of damage depth profiles for vehicle no. 1 (2,4, or 6): 6  
 Damage depth profile for vehicle no. 1: 9,3,12,0,28,1,28,2,26,7,9,3  
 Damage midpoint offset for vehicle no. 1: -21.9  
 Damage width for vehicle no. 2: 0  
 Number of damage depth profiles for vehicle no. 2 (2,4, or 6): 2  
 Damage depth profile for vehicle no. 2: 0,0  
 Damage midpoint offset for vehicle no. 2: 0

==== INPUT DATA AND CRUSH ROUTINE RESULTS =====

25 MPH CITATION - SM, L - D=COG  
 VEHICLE TYPES : 3 7  
 VEHICLE WEIGHTS: 2784.00 3229.00  
 VEHICLE DAMAGE INDICES: 03RDEW5 12FDEW1  
 COLLISION SPEEDS: 0.00 820.14  
 A(2),B(2),G(2): 0.00 0.00  
 DIRECTION OF PRINCIPAL FORCE: 90.00 360.00  
 V1 DAMAGE DATA: 91.50 9.30 12.00  
 V2 DAMAGE DATA: 0.00 0.00 0.00  
 GAM(1;2): 0.91 1.00  
 ENERGY(2): 0.00  
 DELV1: 418.47  
 SUMENG: 1236414.75  
 ENERGY(1): 1236414.75  
 ALPHA1,BETA1: 1908.69 22261.74

Do you want this data entered into your data set  
 to calculate A and B values (Y/N)? N  
 Run again (Y/N)? Y

9.30 -18.02  
 0.00 0.00

26.70  
 0.00

28.20  
 0.00

28.10  
 0.00

Title: 25 MPH CITATION - LG, L - D=COG  
 Size category vehicle no. 1: 3  
 Size category vehicle no. 2: 7  
 Weight of vehicle no. 1: 2784  
 Weight of vehicle no. 2: 3229  
 Vehicle damage indice no. 1: 03RDEW5  
 Vehicle damage indice no. 2: 12FDEW1  
 Impact speed vehicle no. 1 (mph): 0  
 Impact speed vehicle no. 2 (mph): 46.6  
 Direction of principal force for vehicle no. 1: 90  
 Direction of principal force for vehicle no. 2: 360  
 Damage width for vehicle no. 1: 116.5  
 Number of damage depth profiles for vehicle no. 1 (2, 4, or 6): 6  
 Damage depth profile for vehicle no. 1: 2, 22, 6, 28, 9, 30, 7, 12, 2, 2  
 Damage midpoint offset for vehicle no. 1: -9.9  
 Damage width for vehicle no. 2: 0  
 Number of damage depth profiles for vehicle no. 2 (2, 4, or 6): 2  
 Damage depth profile for vehicle no. 2: 0, 0  
 Damage midpoint offset for vehicle no. 2: 0

==== INPUT DATA AND CRUSH ROUTINE RESULTS ====

25 MPH CITATION - LG, L - D=COG  
 VEHICLE TYPES : 3 7  
 VEHICLE WEIGHTS: 2784.00 3229.00  
 VEHICLE DAMAGE INDICES: 03RDEW5 12FDEW1  
 COLLISION SPEEDS: 0.00 820.16  
 A(2),B(2),G(2): 0.00 0.00 0.00  
 DIRECTION OF PRINCIPAL FORCE: 90.00 360.00  
 V1 DAMAGE DATA: 116.50 2.00 22.60  
 V2 DAMAGE DATA: 0.00 0.00 0.00  
 GAM(1:2): 0.95 1.00  
 ENERGY(2): 0.00  
 DELV1: 427.92  
 SUMENG: 1264327.13  
 ENERGY(1): 1264327.13  
 ALPHA1,BETA1: 2246.12 26667.28  
 12.20 30.70 28.90 2.00 12.45  
 0.00 0.00 0.00 0.00 0.00  
 -13.45  
 0.00

Do you want this data entered into your data set  
 to calculate A and B values (Y/N)? N  
 Run again (Y/N)? N

You must now input the Parameter list for A and B values.  
 This will put a range around a guess value of A and B.  
 Make sure to select a range that will encompass the actual  
 value you are seeking. Now enter low range value of A, high  
 range value of A, low range value of B, high range value  
 of B. Separate with commas and enter in integer form.  
 EXAMPLE: For a guess value of A=250 and B=49,  
 Enter: 200,300,40,60  
 Enter: 0,0,0,0

Be sure to list CRUSH1.DAT, before you submit it.  
 If you want to edit it type: EDIT CRUSH1.DAT  
 FORTRAN STOP  
 \$ LOG

## APPENDIX D

### Alternate Crush Measurements and Stiffness Parameters

# RANGE OF DAMAGE MEASUREMENTS

| Vehicle               | Damage Measurements (inches) |     |      |      |      |      |     |       |
|-----------------------|------------------------------|-----|------|------|------|------|-----|-------|
|                       | L                            | C1  | C2   | C3   | C4   | C5   | C6  | D     |
| Escort                |                              |     |      |      |      |      |     |       |
| sm. L                 | 85.0                         | 6.6 | 20.1 | 19.8 | 20.0 | 20.0 | 6.6 | -17.6 |
| lg. L                 | 102.0                        | 3.2 | 19.0 | 19.2 | 19.7 | 18.6 | 3.2 | -14.6 |
| Tredia                |                              |     |      |      |      |      |     |       |
| sm. L                 | 81.0                         | 4.1 | 14.4 | 15.7 | 14.7 | 13.5 | 4.1 | -15.8 |
| lg. L                 | 99.5                         | 0.7 | 11.9 | 16.0 | 14.4 | 13.3 | 0.7 | -12.8 |
| Citation              |                              |     |      |      |      |      |     |       |
| sm. L                 | 81.5                         | 5.2 | 19.6 | 18.1 | 16.9 | 17.0 | 5.2 | -15.0 |
| lg. L                 | 100.0                        | 1.8 | 17.5 | 17.0 | 17.5 | 10.0 | 1.8 | -9.5  |
| LTD                   |                              |     |      |      |      |      |     |       |
| sm. L                 | 111.5                        | 4.1 | 18.9 | 20.5 | 14.8 | 17.9 | 4.1 | -1.2  |
| lg. L                 | 138.5                        | 1.0 | 8.2  | 21.1 | 14.7 | 12.4 | 1.0 | 0.1   |
| non-comp.<br>Citation |                              |     |      |      |      |      |     |       |
| sm. L                 | 107.5                        | 0.0 | 5.1  | 16.0 | 12.2 | 6.9  | 0.0 | 8.5   |
| lg. L                 | 120.0                        | 0.0 | 2.7  | 17.6 | 13.8 | 7.4  | 0.0 | 5.3   |
| 25 mph<br>Citation    |                              |     |      |      |      |      |     |       |
| sm. L                 | 91.5                         | 9.3 | 12.0 | 28.1 | 28.2 | 26.7 | 9.3 | -21.9 |
| lg. L                 | 116.5                        | 2.0 | 22.6 | 28.9 | 30.7 | 12.2 | 2.0 | -9.9  |





TL 242 "MS33 1987 v. 2

Wilke, Donald T.

CRASH III model improvement

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FORMERLY FORM DOT F 1700.11.1

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